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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

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The Materials Testing Congress

After much patient endeavour spread over many years, foundry industrial activities have been accorded by the Government departments treatment similar to that meted out to the iron and steel, textile and other industries. Its technical work was long ago recognised as being of great public benefit by the granting of a Royal Charter by the Privy Council, and the work carried out by the British Cast Iron Research Association is appreciated all over the world. Yet there is still a phase where a greater effort is still requisite, and that is in the direction of increased co-operation with the kindred bodies and international manifestations. One can well understand that it was because of neglect by established bodies to cater adequately for foundry work, that the industry decided to build up its own organisations, both nationally and internationally, and it rightly objects to function as a minor section of some major congress. We have in mind, for instance, the International Congress of Mines, Metallurgy and Applied Geology. There are, however, other congresses, which carry no industrial sectionalisation and in which the foundryman participates, like all others, as an individual technician. In 1935, for example, there was the great welding symposium, and this year, from April 19 to 24, there is to be staged in London an International Congress on Testing Materials. This congress has the active support of thirty scientific associations, including the Institute of British Foundrymen. Guests are coming from twenty-five industrial countries, and over two hundred Papers are to be presented. Many of these have a direct bearing on the properties of castings, and such subjects as creep, corrosion, heat and acid resistance, X-ray examinations, non-metallic inclusions, light alloys and wear and abrasion are to be discussed. Such a manifestation demands not merely a pious blessing given by a resolution at a Council meeting, but rather the personal participation of the individual. If any foundryman has not received particulars, he should write to either Mr. T. Makemson, St. John Street Chambers, Deansgate, Manchester, or Mr. K. Headlam-Morley, 28, Victoria Street, London, S.W.1. Participation in adequate numbers will help in the general movement designed to expand knowledge and prevent specialised investigations being made known to but a limited audience. Through the decades the number of technical associations has been growing in order to meet the demands of changes and developments in industry, and it is thought that this has resulted into too great a dispersal of knowledge difficult for the individual to keep track of, and the International Association for Testing Materials is an effort to create a nucleus for general assembly and publication of such matter.

The Example of South Wales

The Government's proposals for the special areas, recently debated in the House of Commons, are of interest to all who may be contemplating the establishment of foundries. The original Act is to be extended to 1939, and the Special Areas Commissioners are empowered to let factories and sites. The Commissioners are empowered also for the next five years to make contributions in relief of income tax, rates and rent of approved new industrial undertakings. Commitments in England up to nine million pounds have been made since 1934, and in Scotland up to two millions, of which about one-fourth has been discharged in cash. Over forty millions in contracts have been placed in the special and depressed areas during twenty months ending November, 1936, for the defence programme. Munition factories have been established, although in some cases they are intended as reserve capacity. The unemployed have fallen in the period January, 1935, to January, 1937, by more than one-fourth in the special areas, 30 per cent. in Tyneside, 20 per cent. in South Wales, over 30 per cent. in Scotland and 10 per cent. in West Cumberland. The powers now given to the Commissioners should spread the development of light and diversified industries.

While speaking of work in the special areas, we take the opportunity of congratulating South Wales on the publication of its Second Industrial Survey. This three-volume report is the result of eighteen months' work, and its data and conclusions are essential to the study of what South Wales should do to ensure its industrial future. The tinplate industry, which originates a fair amount of foundry orders, comes in for some criticism, and drastic rationalisation is said to be necessary. The nickel industry in the same area is said to be a model of steady employment and socially responsible labour policy. The tinplate industry is reported to have methods and equipment needing to be brought up to date. The attitude to the depressed areas has too often and too long been one of pious hope that they would recover by themselves, but the new proposals and the data becoming available offer a more concrete prospect of recovery, which is essential to the country as a whole.

Foundry Trades' Equipment and Supplies Association

ANNUAL MEETING AND LUNCHEON

Mr. G. T. Lunt presided over the annual luncheon of the Foundry Trades' Equipment and Supplies Association, which was held at the Hotel Victoria on March 10. Amongst those present were Mr. H. Winterton, Mr. R. H. Brackenbury and Mr. V. C. Faulkner, Past-Presidents of the Association; Mr. A. C. Turner and Mr. G. E. France, Vice-Presidents; Mr. E. Cherry Patterson, Mr. E. J. Penston, Mr. O. G. Wilson and Mr. Kenneth Bridges, honorary secretary.

At the annual meeting which followed, the annual report and balance sheet were presented. The latter disclosed assets of more than £300, and a profit on the year's working of £77.

It was reported that space for the foundry section for the Engineering and Marine Exhibition, to be held at Olympia in September, was being rapidly taken up. The organisers acceded to the request of the members that free space should be allocated to the Institute of British Foundrymen for the purpose of a reception room and small technical exhibit.

Election of Officers

Mr. A. C. Turner (General Refractories, Limited) was elected President for the ensuing year, and Mr. G. E. France (managing director, August's, Limited) and Mr. E. J. Penston (Atlas Preservative Company) Vice-Presidents. Mr. O. G. Wilson (Thos. Wilkinson & Company) was elected to serve on the Council. The meeting closed with a vote of thanks to Mr. Lunt for presiding over the Association.

British Scientific Instruments

The progress of scientific activity is in many respects dependent on the accuracy and precision of the instruments and apparatus with which the scientist is able to work, and on the range of instruments that is made available to him. Industry in turn makes increasing demands on science, and there can be no gainsaying the important part which scientific instruments are taking in modern industrial efficiency. Of the instruments, those concerned with optical work take a position of primary importance, and it is fitting that "Optical Devices in Research and Industry" is to be the subject of a conference which is being convened by the Institute of Physics, and which will be held in Birmingham from to-day until Saturday.

Optical instruments have been adapted or developed for a wide variety of purposes. To take only a few examples, they are used for the accurate gauging of screws, for testing the profiles of screw threads and of pivots, and for the measurement of thickness to within one or two ten-thousandths of an inch, replacing progressively the various mechanical gauges formerly used for these purposes. For colour measurement, instruments are now available which will express colour in such a way as practically to identify the agents used for colouring. By this means the colour can be duplicated and not merely matched.

Optical instruments are now used for the detection of impurities present in proportions which might even confound the chemical analyst. It is possible, for example, to determine whether or not steel contains as little as one part in 100,000 of chromium, a proportion which, though extremely minute, is sufficient to affect appreciably the magnetic properties of the steel.

The more spectacular uses of photo-cells are well known, but perhaps their most important application is for measuring the illumination in factories.

Notes from the Branches

East Anglian Section.—The annual general meeting was held at the Central Library, Ipswich, on March 4. The SECRETARY (Mr. J. L. Francis), in presenting his annual report, said that the meeting to discuss the formation of the Section was held on Tuesday, March 24, 1936, and it was followed by the formation of the Section at the first general meeting on May 22, 1936. Membership of the Section was now 44, and in less than 12 months 35 new members had been gained. During that period there had been five meetings, two works visits, and the annual dinner. The average attendance at the meetings was 34, or 77 per cent. Thus, although the numerical strength of the section could well be greater, the support of the members was very satisfactory, especially when the extent of the area served was taken into consideration.

Following the business of the meeting, a short Paper competition was held. Papers had been received from seven members, and these were read by Mr. C. H. Kain. The Papers were entitled:—1, "Cupola Practice"; 2, "Runners and Risers in General Use"; 3, "Cupola Practice"; 4, Runners and Risers on Small Castings"; 5, "Cupola Practice"; 6, "Runners and Risers on Castings," and 7, "Cupola Practice." The result of the ballot was as follows:—1st prize, Paper No. 5, by L. R. Davey, and 2nd prize, Paper No. 6, by R. F. Coates. The secretary announced that during the summer recess three works visits had been arranged.

All the officers were re-elected except Mr. W. B. Lake, and his place on the Council was taken by Mr. C. J. Lake.

Scottish Branch.—Mr. Frank Hudson (Branch-President) presided at the annual general meeting, which was held on March 13 in the Royal Technical College, Glasgow. The secretary, Mr. J. Bell, presented the annual report of Council and financial statements, which indicated that progress had been made during the session. Total membership had increased from 273 to 303, and the attendances at all meetings had been in excess of previous years. The Falkirk section had made good progress in both membership and interest in the proceedings, and it was pointed out that subscriptions were being paid more promptly. The election of officers and members of Council resulted as follows:—President, Mr. Evan J. Ross; Senior Vice-President, Mr. Robert Ballantine; Junior Vice-President, Mr. N. A. W. Erskine; Mr. John Cameron, jun., Mr. A. D. Kirby, and Mr. James Robertson were elected to fill the vacancies on the Council; representatives to General Council: Mr. R. Ballantine, Mr. N. McManus, and Mr. J. W. Donaldson; representatives to Technical Committee: Mr. A. Campion and Mr. J. W. Donaldson; and Mr. John Bell was re-elected secretary.

The CHAIRMAN made reference to the sudden death of Mr. William Moscrip, a member of the Branch. MR. H. WINTERTON (President of the Institute), in proposing the adoption of the report and financial statement, said that it was very satisfactory to know that the Scottish Branch was making such good progress. He was very pleased to see that the hitherto elusive 300 membership had been passed, and he suggested to the newly-elected President that 400 would be a very suitable figure to attain during the next year. It was particularly pleasing to him to note that steps were being taken to ensure a much greater interest of the members in the work of the Branch, and that they were being induced to take a greater part in the discussions. MR. A. LAWRIE (Past-Branch-President) seconded the adoption. The BRANCH-PRESIDENT proposed a vote of thanks to the governors of the Royal Technical College for their continued permission to use the rooms and equipment of the College for the meetings, and to the staff for their assistance.

Random Shots

Recent mention of introducing a little originality into Branch dinners has brought forth a challenge from G. & J. Weir, Limited, of Glasgow, who have gone a long way in that direction in their first smoking concert given for their foundry section recently. The programme does not say with what they "charged" between 7.40 and 8.35, but the general "layout" for their evening's enjoyment certainly shows that the organisers were not lacking in enterprise. The Refractories Association must look to their laurels! There is a background drawing on the programme of a ladle and a cupola "doing their stuff" in a very lively manner, which at once suggests the spirit of the evening.

* * *

One of our erudite dailies says of the Bessemer process: "The phosphorus at the same time is absorbed in the dolomite and tar." We live and learn!

* * *

"Birds can be watched anywhere at any time," began a lecturer on the wireless the other day, "in Hyde Park, for instance." This is nothing new. London's policemen have been doing this for some years now.

* * *

An admiring friend has directed in his will that a certain silver mug in his collection be left to a well-known ambassador. Is this by way of compensation for the iron mask that he frequently wears when about his ambassadorial business?

* * *

In 1407, one Simon Flete, Keeper of the Private Wardrobe within the Tower of London, was paid £25 6s. 8d. for newly making and constructing a certain great cannon newly invented by the King himself. Was it his vast experience with breeches that caused him thus to be singled out for such a job of work?

* * *

Vitreous enamellers will appreciate the story of a little girl who, when recovering from measles, was asked by a neighbour which doctor was attending her. Her reply was, "Well, I've really got two doctors, Dr. —— and Dr. Mellor."

* * *

The Unions of the light castings workers are apparently discussing their grievances connected with the night-shift and three-shift systems. This has been a grievance in their homes for a long time. The preference for the pyjama over the night shift cannot be anything other than an essentially family matter, but when it comes to working in three shifts at once, it affects the wash lady as well. In England housewives like to have a washday once a week and not monthly as they do in Denmark, and Mrs. 'Arris prefers to take her money home every week. She likes her beer little and often, not in large drafts at the end of the month.

* * *

What do you think of the enthusiast for the Hay diet who, after a heavy morning's work, ate a lunch of sprouts and had tummy ache all the afternoon? Was he a cabbage or merely a greenhorn?

* * *

And what price the story of the girl, a saleswoman in a West End dress shop, who said she'd "push" belts like anything down at business, when she heard that her father had invested in leather belting shares.

* * *

Marksman wishes to announce that he has no connection whatsoever with four other gentlemen acting under a similar name, even if he does share with them a liking for the sort of girl you would like to wrap up and take home.

"MARKSMAN."

The Fifth Census of Production, 1935*

IRON AND STEEL FOUNDRIES

TABLE I.—*General Summary.*

Particulars.	Unit.	1935.	1934.
Value of products (gross output) ..	£'000	37,771	33,988
Cost of materials, fuel and electricity used	,,	15,548	13,721
Amount paid for work given out ..	,,	201	135
Net output	,,	22,022	20,132
Average number of persons employed	No.	107,456	99,574
Net output per person employed ..	£	205	202

TABLE II.—*Production, Exports and Imports.*

Kind of Goods.		Production.	Exports.	Retained imports.
		Th. Tons.	Th. Tons.	Th. Tons.
Iron and steel pipes and fittings, cast :—				
Up to 6 in. diameter* :—				
Soil pipes, drain pipes and rain-water pipes (including gutters)¶	1935	155.4	10.8	—
	1934	146.5	13.2	§
Gas pipes	1935	68.5	2.9	0.6
	1934	60.7	4.4	†
Other pipes	1935	189.3	42.0	0.5
	1934	149.9	40.9	0.3
Fittings	1935	—	3.1	0.6
	1934	—	2.6	0.6
Over 6 in. diameter	1935	239.5	36.5	§
	1934	243.6	36.9	†
Stoves, grates and ranges for domestic cooking and heating and parts and fittings therefor‡ :—				
For coal and other solid fuel	1935	130.8	6.7	0.8
	1934	127.5	6.8	0.8
For gas	1935	100.1	2.3	0.1
	1934	89.9	1.7	§
For liquid fuel	1935	1.6	0.3	0.2
	1934	1.8	0.4	0.3
Cooking and washing boilers‡	1935	8.1	1.0	§
	1934	9.3	0.7	§
Sanitary cisterns (flushing tanks)‡	1935	15.3	3.1	—
	1934	15.1	3.0	—
Baths of cast iron or steel ..	1935	54.6	2.9	6.8
	1934	47.2	3.6	7.7
Other sanitary cast iron goods (sinks, basins, lavatories, etc.)	1935	3.3	0.3	0.1
	1934	3.5	0.3	0.2
Manhole covers, ventilation and coal covers, drain gratings and frames therefor, surface boxes and the like	1935	55.1	1.2	§
	1934	55.7	0.9	§

* The figures for exports and imports exclude fittings.

¶ Described as rain-water and soil pipes (including gutters) for oversea trade.

§ Less than 50 tons.

† Re-exports in excess of imports.

‡ The figures for exports and imports may not relate solely to goods of cast iron.

TABLE III.—*Materials, Fuel and Electricity Purchased and Used.*

Kind of Materials, etc.	1935.		1934.	
	Quantity.	Cost.	Quantity.	Cost.
	Th. tons.	£'000.	Th. tons.	£'000.
Materials used :—				
Pig-iron	1,424.5	5,050	1,334.6	4,493
Scrap iron and steel ..	624.0	1,614		
Fuel and electricity used for all purposes :—				
Coal	418.7	380		
Coke	458.3	705		
	Th. Galls.			
Heavy fuel oil	7,597	130	—	9,228
	Th.B.T.U. (Kw.-hrs.)			
Purchased electricity* ..	143,569	427		
All other puchrased materials and fuel	—	7,242		
Total	—	15,548	—	13,721

* Including electricity generated in other works under the same ownership.

TABLE IV.—*Other Output of the Iron and Steel Trade (Foundries).*

Kind of Output.	1935.		1934.	
	Quantity.	Value.	Quantity.	Value.
	Th. Tons.	£'000.	Th. Tons.	£'000.
Goods made :—				
Fencing material (other than fencing wire) of cast or wrought iron	2.6	50	2.5	47
Railway material (including wheels and axles, spikes, sleepers and fishplates) ..	99.3	734	68.3	475
Metal casements and window frames ..	2.7	119	2.2	98
Hollow-ware and utensils for domestic and industrial use ..	—	117	—	90
Machinery and appliances (including parts and accessories)	—	384	—	395
Iron forgings ..	0.6	19	0.6	19
	—	6	—	7
Steel forgings ..	1.2	36	1.2	33
Malleable iron fittings for tubes	6.5	322	*	*
Other manufactures of iron and steel ..	—	133	—	155
Castings of brass and other alloys of copper	3.8	373	2.7	286
Other manufactures of non-ferrous metals ..	—	111	—	135
Other goods made ..	—	132	—	61
Total—Goods made	—	2,536	—	1,801
Scrap metal sold :—				
Iron and steel	35.2	65	46.9	95
Non-ferrous metals ..	1.2	21	0.7	13
Total—Scrap metal sold	36.4	86	47.6	108
Structural work and work done for the trade :—				
Iron and steel structural work†	—	404‡	—	492‡
General and jobbing engineering† ..	—	241‡	—	264‡
Other work done ..	—	32‡	—	24‡
Total—Work done ..	—	677‡	—	780‡
Total	—	3,299	—	2,689

* See footnote (¶) to Table II.

† Exclusive of the value of materials made and supplied by the firm.

‡ Amount received.

TABLE V.—*Consumption of Electricity in 1935.*

Electricity Consumed.	1935.
	Th. B.T.U. (Kw.-hrs.).
Generated in same works	20,951
Generated in other works under same ownership ..	27,685
Purchased	115,884
Total	164,520

TABLE VI.—*Average Numbers Employed.*

Persons Employed.	Males.		Females.		Total.	
	Under 18.	All ages.	Under 18.	All ages.	Under 18.	All ages.
Operatives (average for the year):—						
1935 ..	11,749	91,803	1,822	5,558	13,571	97,361
1934 ..	9,904	84,808	1,534	5,182	11,438	89,990
Administrative, technical and clerical staff* :—						
1935 ..	651	7,793	358	2,302	1,009	10,095
1934 ..	568	7,365	318	2,219	886	9,584
Total 1935	12,400	99,596	2,180	7,860	14,580	107,456
Total 1934	10,472	92,173	1,852	7,401	12,324	99,574

* As at October 12, 1935, and October 13, 1934.

TABLE VII.—*Output of Principal Products.*

Kind of Output.	1935.		1934.	
	Quantity.	Value.	Quantity.	Value.
	Th. Tons.	£'000.	Th. Tons.	£'000.
Iron and steel pipes and fittings, cast :—				
Pipes up to 6 in. diameter, including fittings :—				
Soil pipes, drain pipes and rain-water pipes (including gutters of all sizes) ..	155.4	2,524	146.5	2,393
Gas pipes ..	68.5	581	60.7*	544*
Hot water pipes (including radiators) ..	24.8	346	24.0	371
Other water pipes up to 6 in. diameter	156.6	1,288	116.2*	957*
Pipes (up to 6 in. diameter), not specified above	7.9	113	9.7	120
Pipes over 6 in. diameter including fittings	239.5	1,828	243.6*	1,865*
Total—Iron and steel pipes and fittings, cast	652.7	6,680	600.7*	6,250*
Cast iron stoves, grates and ranges for domestic cooking and heating, and parts and fittings therefor :—				
For coal and other solid fuel	130.8	3,526	127.5	3,612
For gas	100.1	6,305	89.9	5,647
For electricity ..	9.2	489	8.4	409
For liquid fuel ..	1.6	85	1.8	93
Total—Cast - iron stoves, grates, etc.	241.7	10,405	227.6	9,761
Cooking and washing boilers of cast iron (including portableboilers and furnace pans) ..	8.1	188	9.3	218
Sanitary cisterns (flushing tanks) of cast iron	15.3	338	15.1	330
Baths of cast iron or steel	54.6	1,443	47.2	1,338
Other sanitary cast iron goods, enamelled or not (sinks, basins, lavatories, closets, etc.)	3.3	103	3.5	89
Total—Cast - iron boilers, cisterns, baths, etc. ..	81.3	2,072	75.1	1,975
Piano frames	3.1	67	2.9	61
Manhole covers, ventilation and coal covers, drain gratings and frames therefor, surface boxes and the like	55.1	522	55.7	558
Other castings for roads and drainage	9.7	90	13.8	110
Builders' ironmongery, cast, not elsewhere specified ..	7.3	293	3.2	191
	—	61	—	89
Rolls for rolling mills ..	37.9	874	29.2	697
Ingot moulds†	121.3	743	121.1	728
Engineering castings, in the rough or machined :—				
Iron	340.3	6,487	295.1	5,774
Steel	32.7	1,030	32.6	1,068
Malleable iron castings, not included elsewhere¶	47.1	1,742	44.2*	1,634*
Other and unclassified castings :—				
Iron	170.0**	2,861**	282.7	4,226
Steel‡	17.1**	555**	29.5	913
Total—Goods made	1,817.3	34,421	1,813.4	33,946
	—	61	—	89
Casting, etc., for the trade	—	18§	—	31§
TOTAL—PRINCIPAL PRODUCTS ..	—	34,500	—	34,066

* Corrected figures.

† So far as recorded separately.

¶ Excluding for 1935 malleable cast iron fittings for tubes; the figures for 1934 probably include some output of these goods.

‡ Excluding direct steel castings produced by steel manufacturers.

** These figures are incomplete as particulars of the output in the Mechanical Engineering Trade in 1935 are not yet available.

§ Amount received.

* Extracted from the "Board of Trade Journal."

An Aluminium Statue of 1893*

GILBERT'S "EROS"

By PROF. R. S. HUTTON, M.A., D.Sc., and RICHARD SELIGMAN, Ph.nat.D.

At the unveiling ceremony of the statue of Eros in Piccadilly Circus, London, in 1893, the Duke of Westminster spoke of "This beautiful work of art, which will not soon perish." It may well be asked how many metallurgists, with the knowledge of atmospheric corrosion phenomena available to-day, would have endorsed the opinion of the Duke of Westminster. Indeed, even before the year was out there were not wanting those who foresaw disaster, and in September, 1893, the late Edmund Gosse wrote that "the monument already looks dingy and decayed." We know now, however, that the Duke was right, and the imaginary metallurgists of 1893 would have been at fault.

During the building of the present Underground Station at Piccadilly Circus the statue was removed to, and subjected to cleansing at the foundry of Mr. A. B. Burton in Thames Ditton. Almost immediately after its re-erection the statue was damaged in a revel during the night of December 31, 1931, and had to be dismantled once more for repair.

The present authors thought that such an opportunity to inspect the metal should not be missed, and after considerable difficulty received permission to visit the foundry.

Although the cleansing operations had been completed it was quite evident that nothing in the nature of deep-seated corrosion had taken place during the 38 years which had elapsed since the statue was cast. The surface, Mr. Burton stated, had been covered with a layer of corrosion products about $\frac{1}{16}$ in. thick. This had been removed with scrapers, leaving a perfectly smooth surface, only discoloured by the subsequent exposure to the smoke and other atmospheric contamination of Piccadilly Circus. Mr. F. E. Pitts, who, in 1918, acquired the firm of Broad, Salmon & Company, Limited, by whom the statue was originally cast, informed the authors that a similar amount of corrosion products had been removed by electrically driven wire brushes, when the statue had been removed from Piccadilly Circus for safety during the war of 1914 to 1918.

It appeared to be of considerable interest to ascertain the composition of the metal. The intricacy of the casting made it appear that an alloy must have been used, but the evident resistance to corrosion seemed to contradict this view. Some minute drillings were examined spectrographically by Mr. D. M. Smith, B.Sc., of the British Non-Ferrous Metals Research Association, after they had been carefully washed in very dilute hydrochloric acid. Mr. Smith subsequently re-examined the plates secured in 1932 in the light of his later knowledge of the spectrographic analysis of aluminium and reported the figures given in col. 1 of Table I. Mr. Smith emphasised that the numerical estimates are, in all cases, only approximate and should not be regarded as accurate to more than one significant figure. Subsequently, Mr. Pitts kindly supplied a small piece cut, many years before, from the skirt of the figure, which Mr. Smith analysed with the result given in col. 2, Table I.

Whilst these analyses do not show perfect agreement, they do show that no alloy had been used, and it is certainly remarkable that such a casting, reproducing the fine details of Gilbert's work, had been made in "pure" aluminium at so early a date. The bow, Mr. Pitts informed the authors, was re-cast in an alloy at a later date.

Most of those familiar with the metal will also be surprised at the small amount of the impurities revealed, and it was very desirable, therefore, to ascertain the origin of the metal and, particularly, whether it was made by the electrolytic or by a purely chemical process. In this the authors have been entirely unsuccessful, but in the course of their searches they have been fortunate enough to locate several specimens of chemically prepared aluminium. Unfortunately the authors have no sample available of the earliest electrolytic metal for examination by modern methods, but the composition of the samples taken from the statue is very similar to that of metal of known chemical origin. It differs rather more from that of metal produced by electrolysis at about the same time, but metal of composition very similar to that of the statue is frequently produced electrolytically to-day.

TABLE I.—*Analyses of Metal of which "Eros" was made.*

	I.	II.
Iron	0.6–0.7	0.27
Silicon	0.5	0.60
Copper	0.02	0.01
Manganese	0.02	0.004
Titanium	trace	trace
Calcium	trace	trace
Magnesium	*ca.* 0.01	0.001
Silver	—	—
Lead	*ca.* 0.005	trace
Gold	—	—
Zinc	*ca.* 0.005	n.det.
Gallium	trace	trace
Tin	< 0.03	n.det.
Sodium	—	—

n.det. = presence not detected.

It was hoped that a determination of the sodium content would throw light on the problem, since it has been generally assumed that chemically prepared aluminium contained much more sodium than that made by electrolysis. Analyses kindly made by Mr. G. B. Brook revealed, however, 0.002 to 0.004 per cent. of sodium in the sample of metal made by the Bell process, whilst the small piece of the statue gave 0.001 per cent. figures which are similar to those found in pure metal to-day (0.001 to 0.002 per cent.). These figures suggest once more that the metal used for the statue was produced chemically, since Moissan found 0.1 to 0.42 per cent. sodium in metal from the three main electrolytic sources of his day. His determinations were made, however, by the nitrate method, and this process, though the best available then, is not held to be reliable to-day.

* Extracted from a Paper read at the annual meeting of the Institute of Metals in London last week.

Synthetic Pig-Iron

According to an article in "La Technique Moderne," a foundry, owing to the lack of supplies of a suitable hematite pig-iron for its small converter, already in 1915 experimented on the production of a synthetic pig-iron in an ordinary cupola from steel turnings and steel scrap. After a series of initial failures the optimum operating conditions of the cupola were established as follows:—Capacity of cupola, 2 tons per hr.; dimensions of tuyeres, 110 by 55 mm.; blast pressure, 25 cub. m. per min. at 350 mm. w.g. To produce 1,000 kg. of liquid steel in the small converter, a cupola charge is required of 1,170 kg., composed of 1,100 kg. turnings and scrap, 50 kg. of ferro-manganese (with 75 per cent. Mn), and 20 kg. of ferro-silicon in 1-kg. packets of Si. In addition, 6 shovels of limestone and 4 shovels of converter slag were added to facilitate slag formation in the cupola; the coke consumption was 12 to 14 per cent. according to the diameter of the melting zone. By this method a pig-iron is obtained containing 3.04 per cent C, 2.05 per cent. Si, 1 per cent. Mn, 0.64 per cent. P and 0.071 per cent. S. The temperature of the molten cupola iron was 1,450 deg. C.

International Association for Testing Materials

FORTHCOMING CONGRESS IN LONDON

The International Association for Testing Materials is representative of the national Testing Associations or equivalent organisations in over twenty-five of the leading industrial countries of the world; it is controlled by a Permanent Committee composed of representatives of these countries. The function of the Association is to secure international co-operation and an exchange of views, experience and knowledge in regard to materials and their testing. With this object, international congresses are organised at intervals of from three to five years, the last congress having been held at Zürich in September, 1931.

The organisation of the London Congress to be held on April 19 to 24, under the patronage of H.R.H. the Duke of Kent, has been undertaken by a British Reception and Organising Committee, which consists of the British Committee of the International Association for Testing Materials, prominent representatives of British industries, and the representatives of thirty leading British technical institutions and scientific societies.

The subjects for discussion at the Congress have been divided into the following four groups, for each of which a Group President has assumed responsibility:

Group A.—"Metals." (President: Prof. C. Benedicks, Sweden. Vice-President: Dr. H. J. Gough, F.R.S., Great Britain.) Approximate number of Papers, 77. (1) Behaviour of metals (mechanical and chemical) as dependent upon temperature, particularly in regard to high temperatures (25 Papers), (2) Progress of metallography (25 Papers), (3) Light metals and their alloys (14 Papers), and (4) Wear and machinability (13 Papers).

Group B.—"Inorganic Materials." (President: Prof. E. Suenson, Denmark. Vice-President: Direktor P. F. van der Wallen, Holland.) Approximate number of Papers, 63. (1) Concrete and reinforced concrete (43 Papers), (2) Erosion and corrosion of natural and artificial stone (5 Papers), and (3) Methods of testing ceramic bodies (15 Papers).

Group C.—"Organic Materials." (President: Dr.-Ing. R. Barta, Czecho-Slovakia. Vice-President: Prof. J. O. Roos-af-Hjelmsäter, Sweden.) Approximate number of Papers, 45. (1) Textiles (9 Papers), (2) Wood cellulose (10 Papers), (3) Timber preservation (10 Papers), (4) Ageing of organic materials (9 Papers), and (5) Colours and varnishes (7 Papers).

Group D.—"Subjects of General Importance." (President: Prof. H. Rabozée, Belgium. Vice-President: Prof. Dr. M. Ro, Switzerland.) Approximate number of Papers, 25. (1) Relation between the results of laboratory tests and behaviour in use and service (6 Papers), (2) The bearing of recent advances in physics and chemistry on the knowledge of materials (7 Papers), and (3) The properties of materials for the thermal and acoustic insulation of buildings (12 Papers).

Over 200 Papers by leading authorities from about 20 different countries have been received. These have been written in summary form with the object of providing in as short a space as possible authoritative and comprehensive reports on the progress made in each subject during the last five years. The Papers will be published in a Congress Book, together with a record of the proceedings, and reports by the Group Presidents or other qualified rapporteurs.

Full particulars are obtainable from the honorary secretary, Mr. K. Headlam-Morley, 28, Victoria Street, London, S.W.1.

The Graphite Structure of Grey Cast Iron and Its Modification*

By J. G. PEARCE, M.Sc., F.Inst.P., M.I.E.E.

Introduction

The graphite structure of grey cast iron has been the subject of many investigations in recent years. The present Paper briefly reviews work done during the past eight years by the British Cast Iron Research Association, describes a method of graphite refinement as far as it has been worked out, and offers a possible explanation of the observations made. The work began as an investigation into the effects of carbon and silicon and was continued as an investigation into graphite formation in the belief that the way to control graphite size and distribution, which so largely govern the properties of cast iron, lies through an understanding of the manner of its formation.

The production of irons having graphite refined to the smallest possible size offers a marked contrast to the production of irons of the modern high strength type, made by treating iron, which in the section cast would normally be white, with a ladle graphitiser. This process has been termed "inoculation," based on the idea that the ladle graphitiser either directly provided germs or nuclei around which the graphite could crystallise or which actually provoked such nuclei from the melt itself. Characteristic of both processes, however, is the effort to secure a uniform size and distribution of graphite, whether it be coarse or fine, and the relative homogeneity thereby obtained is technically of great value, particularly if the matrix is uniformly pearlitic. The use of inoculation processes has arisen in part on account of the great difficulty hitherto experienced in making castings of varying sections containing uniformly fine graphite throughout.

The type of graphite referred to is variously termed, fine, sleety, nodular, granular, eutectic, pseudo-eutectic. The term most commonly used by the B.C.I.R.A. is "supercooled" graphite, since it appears to arise during conditions of melting and cooling which permit supercooling to take place. One of the early difficulties found by the B.C.I.R.A. was that, in attempting to secure supercooled graphite structures, partial success resulted in the formation of structures containing areas of both supercooled graphite and flake graphite, and possessing mechanical properties inferior to those of either structure obtained exclusively. This supercooled structure has been observed in a number of old photomicrographs and has been produced deliberately by various methods, for example, by Piwowarsky and Hanemann, through superheating, and by Schüz through the chill casting of particular compositions. Its formation is assisted by agitating or jolting or stirring the melt, by steel additions to the charge, and in various other ways. It has also been observed by the B.C.I.R.A. in a number of commercial castings produced in the ordinary way, particularly in castings which are cooled rapidly, such as light castings, certain castings made by centrifugal methods, and in castings made in chills. Figs. 1 shows supercooled graphite in commercial castings. A is an engineering casting cast in a chill die, B a centrifugally cast piston ring, due to Hurst, C a sand cast light casting and D a chill cast stick. The presence of supercooled graphite in such castings forms one of the difficulties in accepting the possible explanation given below.

In referring to the refinement of graphite, the author does not wish to suggest that refinement is necessarily desirable in all cases. While much work has yet to be done to settle outstanding questions, some applications of cast iron will preferably demand a flake graphite structure and others a supercooled graphite structure. Thus for corrosion resistance the former is probably to be preferred and the same may be true for wear resistance. For heat resistance, the latter is to be preferred. In many cases a compromise must be made.

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2 Norbury and Morgan, Journal Iron and Steel Institute (1930), No. 1, page 367.
3 Norbury and Morgan, Journal Iron and Steel Institute (1931), No. 1, page 413. British Patent 323,076.
4 Mitsche and Keil, "Giesserei," March 6, 1931. Le Thomas and Olinger, Bull. Assoc. Technique de Fonderie, October, 1932; La Revue de Fonderie Moderne, April 25, 1933. Thyssen, Journal Iron and Steel Institute, 1934, No. 2, page 153.
5 Norbury and Morgan, Journal Iron and Steel Institute (1932), No. 2, page 301. British Patent 378,508.
6 Norbury and Morgan, "Effect of Non-Metallic Inclusions on the Graphite Size of Grey Cast Iron," Journal Iron and Steel Institute. Advance copy. September, 1936.
7 For reviews of the literature of the effect of titanium and of non-metallic inclusions in cast iron *see* Morgan, B.C.I.R.A. Bulletin, January, 1935, page 82, and July, 1936, page 355.
8 Diepschlag, "Giesserei" (1929), page 822. Diepschlag and Treuheit, "Giesserei" (1931), page 705. Diepschlag and Michalke, "Giesserei" (1934), page 493.
9 Colbeck and Evans, FOUNDRY TRADE JOURNAL, October 5, 1933, page 191.

Recent Developments

During the past ten years progress in the science of founding, leading to grey cast irons of greatly increased strengths, has been due mainly to the reduction in silicon content (by closer control of manufacture), to the use of alloy additions, and to special techniques, such as inoculation, already mentioned, but mainly to the use of a lower carbon content. This results in a smaller quantity of graphite, both by virtue of the lower total carbon and of the increased combined carbon which results, and it is found that with the smaller quantity of graphite, the individual flakes are smaller. The progress made has been of great value and many foundries have adapted themselves admirably to the production of strong irons. This line of development may prove to be the right one for the future. It is, however, accompanied by certain disadvantages in that low carbon irons need higher melting temperatures, often produced by special furnaces. The molten metal has a shorter life and sometimes requires the use of more refractory sands, changes in the design of patterns and castings, more generous risers and runners. There is increased difficulty in machining.

These naturally involve increased costs of production. In short, the iron foundry has been compelled to move towards steel foundry technique. Furthermore, since the whole reason for the existence of many castings lies in the possibility of procuring sections of varying thicknesses in one piece, for complicated designs it is sometimes difficult to use these high-quality irons, the shrinkage of which is too great. Clearly, if the advantages of higher strength can be obtained without sacrificing the carbon content which enables the metal to be so readily melted, soundly cast and easily machined, then a great step forward has been made. This appears to be possible by the production of supercooled graphite structures. In producing these structures, the carbon content is immaterial provided the iron does not contain kish. It needs only to be slightly hypo-eutectic.

In referring to graphite structure, the only distinction made is between supercooled graphite and flake graphite, and even here it is doubtful if the distinction is other than one of size. Various writers have endeavoured to classify the forms of graphite in grey iron, but after examination in the B.C.I.R.A. laboratories of thousands of specimens of commercial grey iron, it has been found impossible to formulate any closer classification, as all sizes and shapes of graphite in between apparently different types can be found. It is understood, of course, that temper carbon found in malleable cast iron and other annealed white irons, formed in the solid state, is excluded.

Finally, the author does not attempt in this brief survey to consider whether supercooled graphite exists in a true eutectic or not. The question as to whether graphite forms directly from the melt or by way of the decomposition of cementite must be regarded as still open.

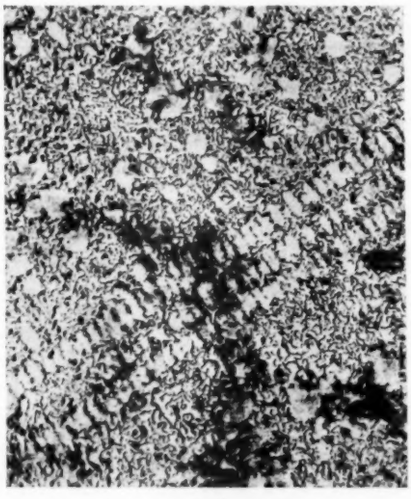

FIG. 1A.—CHILL CAST ENGINEERING CASTING. ETCHED. × 200.

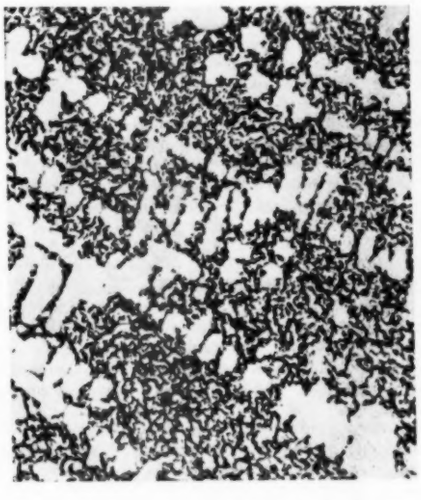

FIG. 1B.—CENTRIFUGALLY CAST PISTON RING. ETCHED. × 200.

Initial Experiments

The work on the effect of carbon and silicon began in 1928 in the preparation of a series of crucible-melted irons. It was found that irons of very similar compositions and cast in the same way but melted under different conditions had widely different microstructures and properties.[1] As a result of a series of melts having carbon contents from 2 to 4 per cent. and silicon from 0.5 to 6.0 per cent., it was found that the structures could be placed in two groups, those containing the usual type of flake graphite and those containing supercooled graphite. In some cases the bars contained both structures, consisting mainly of colonies of supercooled graphite in the ordinary flake graphite structure. Bars

* Institute of British Foundrymen's Exchange Paper to the International Foundry Congress, Düsseldorf.

containing supercooled graphite were mainly ferritic and those containing flake graphite were pearlitic, the combined carbons of the former being lower than the latter for irons of otherwise similar composition.

Figs. 2 shows curves for bars of specified diameters separating white and mottled irons from grey irons. A gives curves for irons containing flake graphite and B for irons containing supercooled graphite. It will be seen that the supercooled irons show a greater tendency to

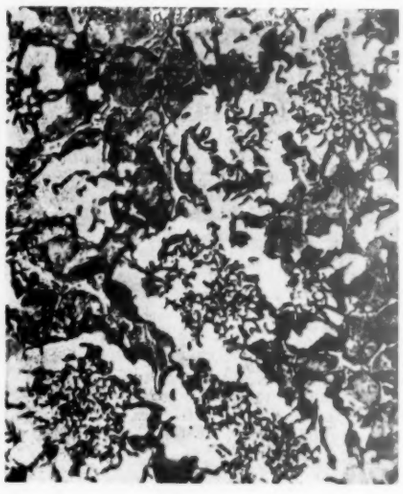

Fig. 1c.—Sand Cast Light Casting. Etched. × 200.

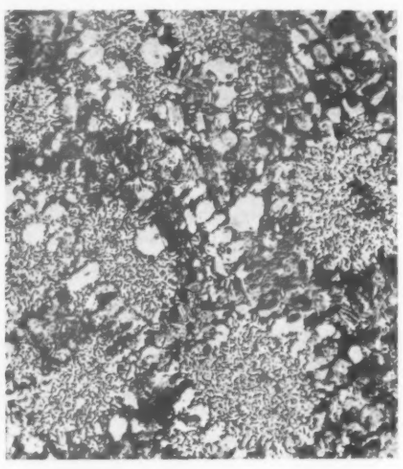

Fig. 1d.—Chill Cast Stick. Etched. × 200.

chill and hence require a higher silicon content to keep them grey. These data were of service in preventing difficulties arising from the use of superheating to obtain refinement. In endeavouring to realise in practice the refinement associated with superheating, as established by Piwowarsky and Hanemann, inverse chilling, that is the presence of cementitic areas in the centre of a section surrounded by grey iron, was frequently experienced. The irons containing supercooled graphite were dull black or sooty in fracture, the normal graphite irons being of the usual steel-grey granular fracture. In the former irons the phosphide network structure was much larger. Attention was drawn to the striking structural parallel between supercooled and flake graphite irons and the modified and unmodified aluminium-silicon alloys.

Subsequently it was found that the order in which the constituents of the charge were melted had a marked effect in determining structure and hence properties, and that this, indeed, was more important than comparatively wide variations in chemical composition.[3] The differences in melting conditions thereby arising produced differences in structure, supercooled graphite in some cases and flake graphite in others. Again, in some cases both structures appeared and the bars then had inferior mechanical properties. The change from fine to coarse graphite in such cases was apparently continuous.

Among other points, it was found that stirring 40 per cent. ferro-silicon into a charge invariably produced flake graphite. Conversely, steel additions caused a marked refinement, while a direct graphite addition recoarsened it. The action of ladle graphitisers ferro-silicon, calcium silicide, etc., on white irons, in forming strong grey irons of flake graphite structure was confirmed, as was the effect of superheating.

Heat-Resisting Irons

Arising out of the investigation on the effects of carbon and silicon, some interesting heat-resisting properties of irons (Silal) relatively high in silicon were discovered,[3] and these properties were subsequently confirmed.[4] The iron found most suitable to resist heat in the iron-carbon-silicon series had about 5 per cent. silicon with comparatively low carbon and a supercooled graphite structure. The heat-resisting properties were to be attributed to the heat-resisting matrix, high in silicon; the fine graphite, which restricted penetration of oxidising gases along the graphite cavities; the action of the silicon content in raising the critical point; and the absence of combined carbon, the structure being wholly ferritic and hence not liable to carbide breakdown. The main handicap in the practical use of these irons lay in their comparative brittleness, arising from the presence of silicon, and in order to overcome this, a much more ductile austenitic iron (Nicrosilal) was developed.[5] The structure consists of austenite and fine graphite, with or without free carbide, as may be required.

The point of interest in the present connection is that it was not appreciated at first that the supercooled structure of the original Silal irons arose from the conditions of melting, and in ordinary practice metal made from commercial furnaces frequently contained flake graphite, which tended to reduce the heat-resistance. Fig. 3 A shows the supercooled structure of good Silal and 3 B of Nicrosilal.

In an extension of these investigations dealing with graphite formation, many obscurities arising from the earlier work have been explained, and the conception of graphite formation is placed on a much sounder basis.[6] The summary below is necessarily brief and the original Paper should be consulted for details.

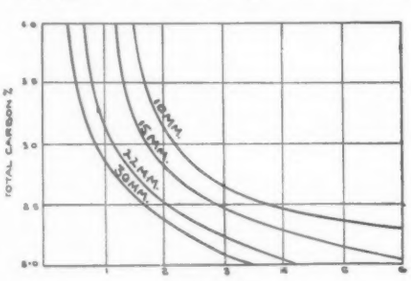

Fig. 2a.—Lines of Equal Chill for Bars of Varying Diameters. Flake Graphite Irons.

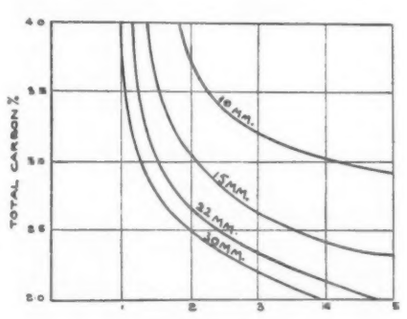

Fig. 2b.—Lines of Equal Chill for Bars of Varying Diameters. Supercooled Graphite Irons.

Crucible Melts

Until the beginning of this last mentioned investigation in 1932, the usual nucleus theory relating to variations in graphite size was used, although it was appreciated that this theory was never wholly satisfactory, and failed to explain various points which could be urged against it. For example, the rapid re-melting at low temperature of a piece of white iron and a piece of grey iron from the same casting gave identical structures on solidification. If the nucleus theory were correct, it would be expected that the grey iron would have a coarser structure. Other possible causes of variation in graphite size were considered, among them being gases and non-metallic inclusions. A large number of tests were made melting small 120 gm. charges of a synthetic grey iron (of about 1 per cent. Mn) of fireclay crucibles at about 1,350 deg. C. in a Silit electric furnace. Melts were then treated to remove inclusions, to introduce others, and also with gases and deoxidisers. As the sulphur was below 0.03 per cent., sulphide inclusions were small. Hydrogen was found to coarsen the graphite, while nitrogen refined it. Hydrogen, in excess, produced pronounced blow holes. Steam had a similar action, apparently being reduced. Such reduction was more rapid in irons containing oxidisable elements, and more marked in low carbon irons. Nitrogen completely removed the effect of hydrogen, as did carbon dioxide and air, and in itself tended to refine. Apart from the effect of hydrogen, these experiments threw little light on the graphite size problem, and a low manganese iron, 0.03 per cent., failed to respond to hydrogen and nitrogen in the way indicated.

A number of 1.5 per cent. phosphorus irons were then tried, but some were refined by nitrogen, others were not. It was thought that this refinement by nitrogen might be due to the formation of a nitride. Many attempts were made deliberately to form a nitride in the melt without success, except that ferro-carbon-titanium additions appeared to clean melts not refined by nitrogen, and, if followed by nitrogen, sometimes partially refined. At this stage titanium was not considered to be responsible for this partial refinement, since no clear evidence existed that titanium refined graphite size.[7] It was thought that the ferro-carbon-titanium merely cleaned the melt and that some further treatment was necessary to procure refinement. Various treatments were applied, including one in which calcium carbonate was added and the resulting structure was completely refined and quite unlike anything that had previously been obtained.

A melt containing ferro-carbon-titanium treated while molten with carbon dioxide, gave the same result and several experiments showed that 1 to 2 per cent. of ferro-carbon-titanium was sufficient and that the graphite was only refined when the melt was oxidised. It was established that the passage of carbon dioxide for two minutes was sufficient to give the maximum graphitic refining effect. Applied to a large number of hypo-eutectic cast irons of the most varied compositions, it was found to refine them all, although some were not so com-

pletely refined as others. In hyper-eutectic irons the presence of kish graphite had a coarsening effect on the fracture. Hydrogen was found completely to coarsen refined structures, although under the conditions of these experiments ferro-silicon, calcium silicide and other graphitisers failed to coarsen them.

The original sample which was partially refined by nitrogen, was then analysed for titanium and was found to contain 0.15 per cent. This metal was more fully refined by carbon dioxide than by nitrogen and completely by an addition of ferro-carbon-titanium, followed by passage of carbon dioxide. Since, in an atmosphere of nitrogen, refining did not occur, the effect of nitrogen was established as indirect. It churned the metal and exposed it to surface oxidation. The low manganese (0.03 per cent.) iron which failed to refine by nitrogen, was then found to contain only 0.05 per cent. titanium, and it also was refined by an addition of titanium followed by carbon dioxide treatment. This difference was traced to the fact that the former iron was made from 40 per cent. ferro-silicon and the latter from a 30 per cent. ferro-silicon. As both ferro-alloys had been obtained from the same source, it was assumed that they had been made from the same materials, but the 40 per cent. ferro alloy was found to contain 1.74 per cent. titanium and the 30 per cent. only 0.08 per cent. titanium. The latter turned out to be an odd lot from a Norwegian furnace and a subsequent supply contained only 0.06 per cent. titanium.

Thus the difference in melting conditions resulting in a pronounced difference in graphite structure was finally traced to the differing titanium contents of the ferro-alloys used, a difference of which the investigators and even the suppliers of the ferro-alloys were originally unaware. As a result all the ferro-alloys, pig-iron and scrap used were analysed for titanium, which varied from 0.04 to 1.74 per cent., the titanium contents broadly determining the fineness of the structure obtained on remelting a hypo-eutectic iron followed by oxidation. The true explanation of differences found in the earlier investigations referred to above began to emerge.

In view of the work of Diepschlag and his co-workers,[8] and of the refining action of sodium carbonate on graphite,[9] attempts were made to refine irons containing traces of titanium with a slag of suitable composition, but no appreciable refining or coarsening could be obtained, nor could a melt refined by titanium plus carbon dioxide be coarsened by slag incorporation. It appeared to be very difficult to introduce non-metallic inclusions from outside.

In view of the ideas formed as to the reasons for the refining action, experiments were made on irons low in silicon. A Swedish white iron containing only 0.2 per cent. silicon was graphitised with 20 per cent. pure nickel. It gave ingots having chiefly supercooled graphite in the microstructure. Such melts were apparently almost free from inclusions and hydrogen treatment did not appreciably coarsen them, although treatment with titanium plus carbon dioxide refined them completely and hydrogen treatment, after refining with titanium and carbon dioxide, coarsened them completely. This suggested that the action of hydrogen was essentially reducing. Swedish white iron, if melted without loss of carbon, gave an ingot which was just grey and this contained chiefly supercooled graphite.

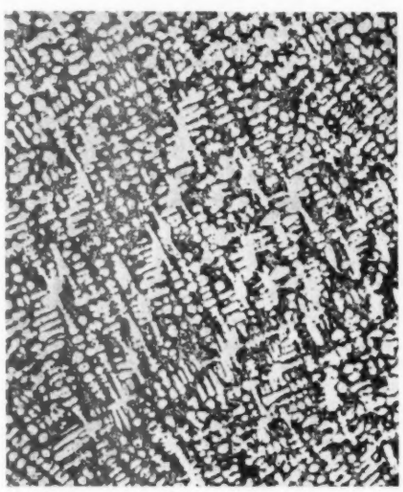

FIG. 3A.—SUPERCOOLED STRUCTURE OF SILAL (FERRITIC IRON). UNETCHED. × 50.

FIG. 3B.—SUPERCOOLED STRUCTURE OF NICROSILAL (AUSTENITIC IRON). UNETCHED. × 50.

Additions of 0.1 per cent. aluminium to the Swedish white iron coarsened the structure, but by oxidising the aluminium out of the metal, the resulting graphite structure was extremely fine.

The addition of copper to an iron containing silicon normally refines the flake graphite structure slightly. If, however, copper is added in excess of the liquid solubility limit, the graphite is completely supercooled. This possibility was deduced from the theoretical explanation, to be dealt with later, and confirmed by experiment.

(To be concluded.)

Dutch Pig-Iron Exports

Owing to the abolition of the import duty on pig-iron entering Great Britain, the directors of the Kon. Nederlandsche Hoogovens en Staalfabrieken are to examine the question whether it would be possible to resume exports to the United Kingdom. In 1931 the company exported 65,000 tons of pig-iron to this country, but the trade ceased when the 33⅓ per cent. duty was imposed in 1932. If exports are resumed, the tonnage involved is likely to be small.

(Concluded from next column.)

MR. A. W. WALKER, proposing a vote of thanks to Mr. Smith, said the Paper had covered many things of which members of the industry in the jobbing foundries of the West Riding probably knew very little. He must admit that they might have been equally interested if Mr. Smith had given even more attention to problems of heating for general work, as distinct from speciality jobs. MR. S. CARTER, supported by MR. S. W. WISE, seconded the vote of thanks.

Modern Core Shop Methods

DISCUSSION AT BRADFORD

Mr. Joseph Hepworth, M.P., Branch-President of the West Yorkshire Branch of the Institute of British Foundrymen, presided over a large attendance at a meeting of the Branch, at Bradford Technical College recently, at which a Paper was presented by MR. W. H. SMITH, on "Modern Methods in the Core Shop." Mr. Smith's lecture was published in our issue of February 11.

In answer to a question as to whether there was any substantial variation in blowing pressures in a core blower machine, MR. SMITH said the usual pressure was between 80 and 100 lbs. On a small job a pressure of 60 lbs. might be used, but he did not advise working with low pressures as a general rule.

MR. W. G. THORNTON, Past-Branch-President, inquired whether more use could advantageously be made of automatic sand conveyors to the core bench. Could Mr. Smith give a range of temperatures to be recommended for the continuous stoves, and did the use of these stoves involve extensive maintenance costs and replacement of chains and other parts?

MR. SMITH replied that the sand conveyor system was used in some core shops, but, in his own opinion—and the small amount of practice seemed to support it—it was not worth while, because the tonnage of sand to be conveyed in the core shop was relatively small compared with conveying requirements for moulding sand in the foundry. Its value was still more questionable when one remembered that it was often necessary to use three or four grades of sand; in one of the foundries described in his lecture no less than seven different grades of sand were used. Mr. Smith described, however, some rail and bucket conveyor systems in use in certain core shops within his knowledge. In regard to temperature inside the continuous stoves, Mr. Smith described and illustrated a stove in which the average temperature was 375 deg. Fah., but could vary between, say, 250 deg. and 500 deg. Fah. If the core oils would withstand a higher temperature, the drying time would be shorter; but the usual temperature was about 450 deg. Fah. Maintenance and replacement costs had been very low in all cases within his experience. No lubrication was required inside the continuous stove, and the installation had large bearings. He knew of no case in which any bearings or chain had to be replaced.

A MEMBER, presuming the fuel for the stoves was furnace coke, asked whether the air-blast system was not likely to have powder deposit effects on the cores. He would also like to know if Mr. Smith had any ideas on preventing re-absorption of moisture in stored cores.

MR. SMITH replied that there was a small deposit of powder from the furnace coke, but he had never heard of it being in any way detrimental. In connection with core storage, he described several specially-fitted core storage chambers with the installation of which he had been concerned. He suggested that normally a pure oil-sand core would not take up moisture if properly dried.

In reply to a question by MR. A. W. WALKER, Past-Branch-President, concerning comparative costs of coke and town gas for drying stoves, MR. SMITH said records in his possession indicated that costs when using furnace coke varied between 9d. and 1s. 4½d. per ton of cores on coke prices of six months ago, but prices had advanced since then. He had no tonnage figure immediately available in regard to gas. He was quite satisfied there was no comparison in the matter of cost, though, if it were only a question of heat, town gas would have a great chance on volume drying.

(Concluded in previous column.)

Colloidal Graphite as a Die-Casting Lubricant*

By William Jennings.

The lubrication of die-casting mechanisms that are subjected to high temperatures is oftentimes a difficult problem, inasmuch as most lubricants either lose their viscosity or chemically decompose under high heat. Experience has shown, however, that of all lubricants compounded for the purpose those containing colloidal graphite are capable of overcoming this difficulty and similar problems in the high temperature field. Not only do the graphoid surfaces formed by such a material possess a low coefficient of friction and act as a protective coating on moving parts, but they are also resistant to oxidation and are incombustible at temperatures below 600 deg. C. A consideration of this material from the standpoint of actual die-casting procedures follows.

The word die-casting is limited properly to those parts produced from metal moulds or dies, the exerting forces being either gravity or the pressure from hand-operated plungers, pneumatic and hydraulic devices. This pressure is maintained until solidification is complete. The dies are usually made from some specially heat-treated alloy like chromium-vanadium steel, and are applicable for casting the yellow metals as well as those alloys having a zinc, tin, lead, or aluminium base. One of the reasons for the use of such metal dies is to obtain within narrow limits a well-finished and solid casting that requires little or no machining. Although accurate lathe methods produce the required smooth finish, the purpose of the die, however, is somewhat defeated if its surfaces are not treated with a non-gumming lubricant or parting solution like an aqueous dispersion of colloidal graphite, as, for example, "Aquadag."

In practice, the dies or cores are first dipped into a sodium hydroxide solution in order to cleanse them of any absorbed grease-like substances. Where the parts requiring treatment are too large for immersive purposes, petrol is brushed over the surfaces to be cleaned. The concentrated colloidal graphite product as commercially sold is then diluted with water to the proper consistency and worked over thoroughly to eliminate any agglomerates. The three main methods of coating a mould with this material are spraying with such devices as the De Vilbiss gun, dipping into prepared baths, and swabbing with a brush, listed in the order of their most efficient and economical use. Several coats are initially applied in order to obtain the proper metal impregnation or to form the so-called graphoid surface that enables the free and rapid flow of metal essential to well-formed castings. The surface thus formed is then polished whenever possible. In some instances the graphite deposit may function better if the mould is heated to a temperature above the boiling point of water, say 125 deg. C. This temperature, however, should not be so high as to make the water flash and dislodge the graphite particles. Following the initial treatment with the graphite material the frequency of subsequent applications depends upon the speed of production and the difficulty of removing the cast objects, both factors of which are determined by the operator.

A mould and core wash applicable to general conditions consists, it is said, of one part by volume of concentrated graphite to ten parts of distilled water. For temperatures around 400 deg. C. one-fourth part by volume of sugar or glucose is added to the above solution. For work up to 700 deg. C., 6 per cent. of heaviest density commercially pure sodium silicate is recommended, while an approximate amount of borax solution is required when work is done at temperatures up to 1,000 deg. C.

Where it is necessary to chill the cores after each cast, the graphoid surface can best be maintained by a mixture of one pint colloidal graphite to twenty gallons of water. When operating at higher pressures with various pressure machines, a solution of one pint colloidal graphite to five gallons of water has been reported as being satisfactory. Oftentimes, when making special castings, difficulty is experienced with certain metal sections due to slow chilling, shrinkage, etc. In such cases a one to ten solution of colloidal graphite and water should be used for painting on those parts of the mould where it is desired to conduct heat away rapidly or where there is a tendency for them to bind in the casting. Graphite, according to some users, readily carries the heat away in cases where heavy sections are cast.

It has been pointed out that a solution of colloidal graphite and water on dies considerably improves the formation and finish of the castings made therefrom. Other advantages of such graphite deposits are the tendency to lengthen their operating life and to reduce scrap. Old dies which have become checked may be continued in use by treating their surfaces with concentrated colloidal-graphited water and buffing, upon drying, the graphite film which results. Since cores can be more readily removed, production is materially increased. According to many producers, graphite of colloidal dimensions is more desirable in the above respects than the flake or crystalline graphite because of its greater adhesive properties.

In conclusion, it is worth while noting that more efficient production can be maintained by occasionally treating with a colloidal-graphited oil the core slides, plugs, screws, hinges, or other moving parts of the die-casting mechanism. When applied to push pins, this lubricant is especially effective in the elimination of sticking. Full realisation of the value of colloidal graphite dispersions for die-casting processes can only be attained following their actual shop use.

* From the "Iron Age."

(*Concluded from next column.*)

Paper No. 8.—J. E. Hurst: "Some Experiments on the Influence of Silicon, Phosphorus and Manganese on Nitrogen-Hardening Cast Iron."

Paper No. 9.—J. A. Jones: "The Effect of Phosphorus on the Mechanical and Corrosion-Resisting Properties of Low-Carbon and of Low-Alloy Structural Steels."

Paper No. 10.—H. A. Miley: "The Thickness of Oxide Films on Iron."

Paper No. 11.—H. O'Neill: "Alloy and Fine-Grained Steels for Locomotive Coupling Rods."

Paper No. 12.—A. M. Portevin and R. Castro: "The Morphology of Inclusions in Siderurgical Products. Parts IV and V."

Paper No. 13.—D. G. Sopwith and H. J. Gough, F.R.S.: "The Effect of Protective Coatings on the Corrosion-Fatigue Resistance of Steel."

Autumn Meeting

By invitation of representatives of the local iron and steel industries the autumn meeting will be held at Middlesbrough on September 14 to 17, 1937. Full particulars will be issued in due course.

Steel Corporation of Bengal

An issue is to be made in London about the middle of April of £1,000,000 4 per cent. sterling convertible debenture stock of the Steel Corporation of Bengal, Limited. At the same time, the Corporation will make a rupee issue in India of £3,000,000 of 5 per cent. cumulative preference shares and ordinary shares. The Corporation is erecting steel plant at Hirapur, with an initial output capacity of about 200,000 tons a year. For this the company will draw its requirements of iron from the Indian Iron & Steel Company, Limited.

Iron and Steel Institute

PROGRAMME OF ANNUAL MEETING

The annual meeting of the Iron and Steel Institute will be held, by kind permission, at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on Thursday and Friday, April 29 and 30, commencing each day at 10 a.m.

Thursday, April 29.

The general meeting will be opened at 10 a.m. with the presentation of the annual report and statement of accounts for 1936. Other business will be the election of new members; the induction of newly-elected President, Mr. Alfred Hutchinson, M.A., B.Sc., into the chair; the presentation of Bessemer Gold Medals; and the presidential address.

Thereafter Special Report No. 16 will be presented for discussion.

At the afternoon session, the following Papers will be presented:—Nos. 6, 13, 11 and 8.

Friday, April 30.

The general meeting will be continued at 10 a.m., with announcements of the award of the Andrew Carnegie Research Scholarships for 1937, of the award of the Carnegie Gold Medal, and an announcement will be made regarding the award of the Williams Prize. The following Papers will be presented for discussion:—Special Report No. 17; Papers, Nos. 7, 10, 9 and (if time permits) No. 2.

At the afternoon session the following Papers will be presented for discussion:—Nos. 1, 4, 5 and 3.

Annual Dinner

The annual dinner will be held at Grosvenor House, Park Lane, London, W.1, on Thursday, April 29, at 7 for 7.30 p.m. Applications for tickets (price 15s. each, exclusive of wine) should be sent in not later than Thursday, April 22.

List of Papers

The following is a complete list of the Papers offered for the annual meeting, 1937:—

Special Report No. 16.—"Seventh Report on the Heterogeneity of Steel Ingots," being a Report by a Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation to the Iron and Steel Industrial Research Council.

Special Report No. 17.—"The Work of the Coke Research Committees of the Iron and Steel Industrial Research Council, by E. C. Evans and J. M. Ridgion.

Paper No. 1.—F. Adcock: "An Investigation of the Iron-Carbon Constitutional Diagram. Part I.—Preliminary Survey of the δ Region."

Paper No. 2.—Sven Brennert: "Method for Testing the Resistance of Stainless Steels to Local Corrosive Attack."

Paper No. 3.—S. C. Britton: "Some Properties of Commercial Steel Sheets Containing Copper, Chromium and Phosphorus."

Paper No. 4.—H. Esser: "The Allotropy of Iron."

Paper No. 5.—Marie L. V. Gayler and C. Wainwright: "Alloys of Iron Research. Part XII.—Note on the βM Transformation in Manganese-Rich Iron-Manganese Alloys."

Paper No. 6.—H. J. Gough, F.R.S., and D. G. Sopwith: "The Influence of the Mean Stress of the Cycle on the Resistance of Metals to Corrosion Fatigue."

Paper No. 7.—Sir Robert Hadfield, Bt., F.R.S., and S. A. Main: "A Practical Trial of Roofing Sheets of Copper Steels and Other Materials."

(*Concluded in previous column.*)

Foundry Mechanisation

By A. S. BEECH

(*Concluded from page* 211.)

Semi-Mechanisation of a Small Foundry

Attention is now drawn to an important development which has recently been made for the purpose of mechanising or partially mechanising smaller foundries, which have not much money to spend or are handicapped by lack of floor space, or only have need for limited outputs. This problem has arisen on so many occasions that a real effort has been made to solve it. Unfortunately a photograph could not be taken of the installation so Fig. 7 has been prepared of a general arrangement of this plant.

The machines are placed all along one side of the shop and have individual hoppers fed with an overhead belt and ploughs, over each machine. There is a comparatively small space in front of the machines and consequently there is no room for a mould conveyor unless it be so small as to be of little use. In the case under consideration, the floor space available is only 83 ft. long by 23 ft. 3 in. wide overall, hence it will be understood that this is a real difficulty to mechanise.

The moulds are made on the machines and are placed on the casting floor where they are cast as quickly as possible, and then are knocked out over a grid running along the opposite side of the shop to the moulding machines. Under this grid is running an endless belt of high heat-resisting quality which takes the sand to the end of the shop, where it is elevated into a storage hopper, which feeds the sand into the sand mill in the required charges. This sand mill is not a continuously-operated mill but of the batch type capable of dealing with about 3 to 4 ton of sand per hour. On the other hand the mill might be termed semi-automatic, because when the milling is finished the sand is automatically discharged through an orifice in the centre of the mill down a shute and fed into the boot of a further elevator which lifts the sand to the top of the building and passes it through the disintegrator on to the belt feeding the individual hoppers over the moulding machines. Moreover, this belt continues on and discharges the surplus sand to the hand-moulders section, when required. It must be understood that this lay-out is not by any means a completely mechanised plant, but it does go to prove once more that, provided the desire to progress really exists, there is normally no foundry in this country large or small which could not adopt some form or another of mechanised means which if carefully thought out would result in far better products at a lower price.

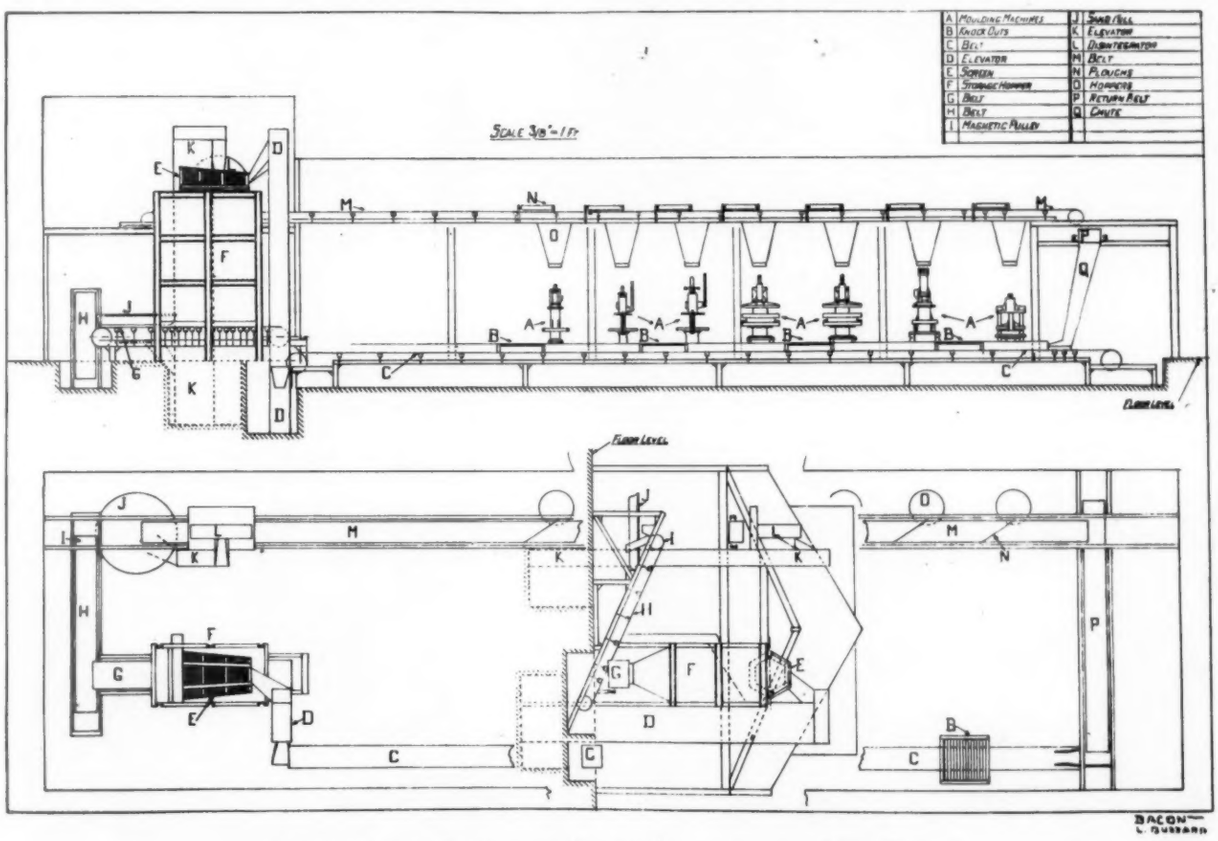

FIG. 7.—GENERAL LAY-OUT FOR SEMI-MECHANISATION OF A SMALL FOUNDRY.

Knocking-Out Moulds

Criticisms have been levelled at designers and builders of mechanised plants in the past in respect of the knock-out stations, and it must be admitted that in the old-fashioned plants this was the worst section in the whole of the plant from the point of view of the men who had to work there. As a rule a stationary grid was provided and the moulds had to be pulled off the mould conveyor, and the men were expected to knock the sand and casting out on to the stationary grid, and in many cases, poke the sand through the grid with bars or other implements. The result was that these men were working in a terrible atmosphere and breathing the sand and steam into their lungs all day long. The latest methods are, however, much more humanitarian, since the mould presents itself on a mould conveyor in front of a jolting knock-out grid.

Fig. 8 shows a knock-out grid and knocking-out station situated on one side of a mould conveyor and fed by a pushing-off apparatus which is composed of a piston and cylinder actuated by compressed air or hydraulic power. At the head of the piston is fitted a pusher with shock springs, whilst guiding rods are also fitted. As soon as the mould arrives at the knock-out station, the man in charge pulls a lever which opens the valve and the push-off piston operates straight across the face of the mould conveyor and pushes the box on to the jolting grid. The jolting grid shakes all the sand through the grid, and the empty moulding box is placed on a power-driven roller conveyor (which is only power driven for say about 12 to 14 ft. long) and which first elevates the empty box to the required height for return to the moulding machines on gravity rollers. Underneath the jolting grid is arranged a modern system of suction fan and ventilation so that all steam and dust are taken away automatically. Consequently the men are operating in a decent atmosphere, and the terrors of knocking-out, which are certainly present on old-fashioned plants, were not perpetuated in the new installations described.

Facing Sand Problems

In some foundries, particularly where a good skin is needed on the casting or where the casting has to pass through a vitreous enamelling process, the facing sand problem is a most important one. In this respect, those foundries

which have not to produce a very fine skin on the casting are particularly fortunate, because the facing sand problem means a considerable loss of time and an added expense to the production of the casting. The methods of eliminating the arduous work of sieving the sand on to the pattern plate have now been carefully studied in one of the latest modern plants installed in this country for the production of castings which have to be vitreous-enamelled, and in this there are two sand plants installed; one deals with the backing sand and the other with the facing sand.

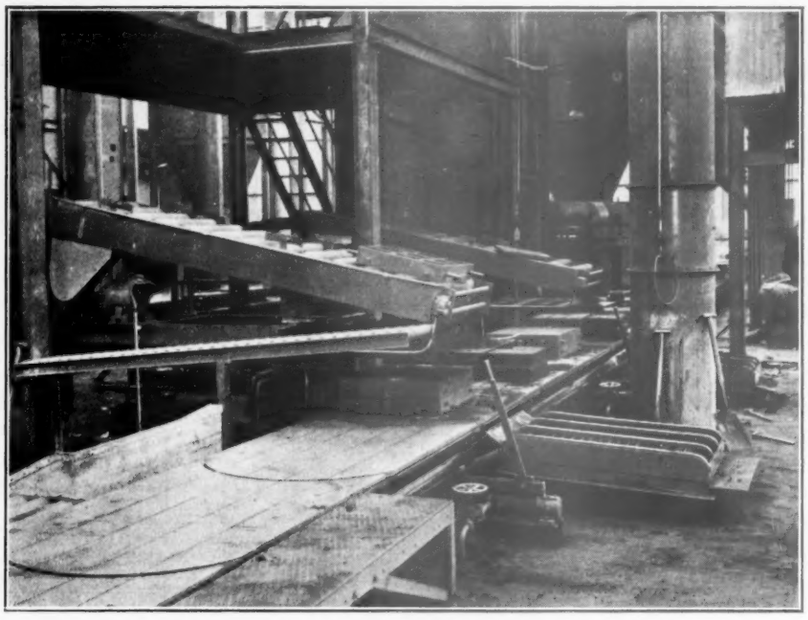

Fig. 8.—Jolting Knock-Out Grid.

In this plant, the facing sand is brought by a supplementary belt to a secondary hopper situated in the vicinity of the moulding machines. A new type of automatic riddle, actuated either by compressed air or electricity, has been designed and this is kept full of sand from the supplementary hopper referred to. As soon as it is necessary to put the facing sand on to the pattern plate this riddle is swung over the pattern plate and the same swinging-over action opens the valve or switch, and sieves the facing sand automatically on to the pattern plate. When this operation is completed the riddle is swung back out of the way, and as it passes back the air or electricity supply, as the case may be, is cut off and the vibratory action ceases. The backing sand is then fed from the hopper in the usual manner.

Cooling the Sand

It is not generally appreciated that the cooling of the sand is of supreme importance, and when studying this question it is essential that all prospective users of mechanised plants should feel sure that the sand will be cool when it returns to the individual hoppers situated over the moulding stations. It is not necessary to explain to foundrymen the troubles which will certainly occur if the sand is hot or steaming when it returns to the moulding stations. As a result of this, precautions have to be taken, and already improvements have been made in this direction in some of the modern plants installed during the past twelve months.

Synthetic Sand

It is felt that the use of synthetic sand, that is to say, silica sand with an addition of mineral or colloidal clay, in mechanised plants should be considered. It is difficult to understand how it comes about that in a country such as Great Britain, which without doubt possesses the finest moulding sand in the world, some of its leading foundrymen are actually advocating the use of this synthetic sand in the foundries. The main objection to synthetic sand in a mechanised plant is its silt content, which is extremely bad when included in the reconditioned sand, and also is very prone to get into bearings, etc., despite all precautions which may be taken to exclude it.

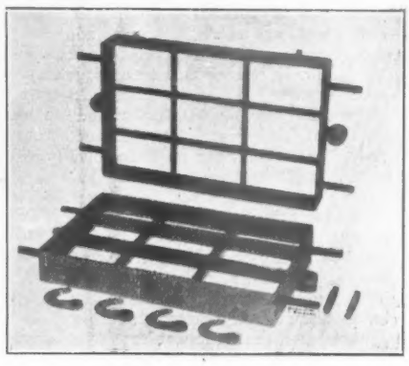

Fig. 9.—Set of High-Tensile Steel Moulding Boxes with Loose Closing Pins, Clamps and Spigots.

Pattern Plates, Runners, Gates

It is, of course, essential that such matters as pattern plates, runners and gates receive every possible attention, particularly on a mechanised plant and where repetition castings are being made. Frequently a large quantity of scrap castings is produced because pattern-plates are bad or inaccurate, or because gates and runners have been put in the wrong place, or dimensions are incorrect. Obviously, therefore, every care should be exercised in these directions. Runners on pattern plates should be in every case cut automatically to correct size and shape during ramming operations, and the old-fashioned method of cutting these by hand by means of tubes and the like should be definitely discarded.

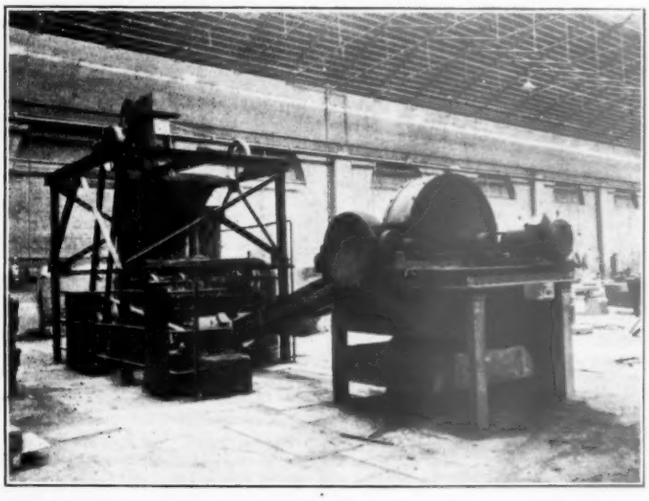

Fig. 10.—Sand Reconditioning Plant at a Steel Foundry in the North of England.

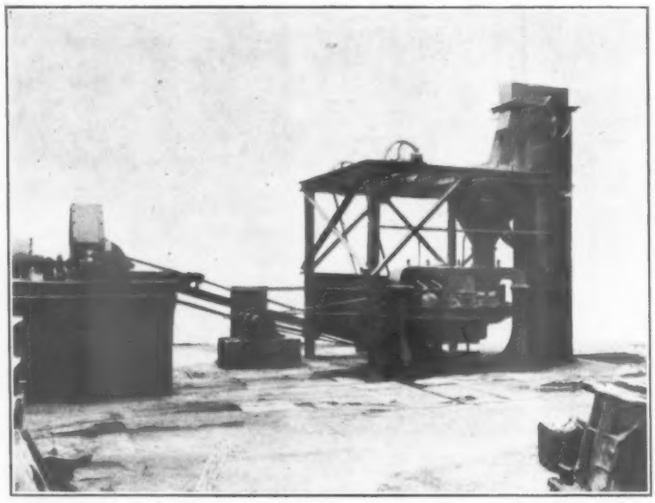

Fig. 11.—Another View of the Sand Plant shown in Fig. 10.

Moulding Boxes

One of the main advantages to be gained from a mechanised plant is that the quantity of moulding boxes can be reduced to a minimum, as they are being used over and over again during the day. Consequently, when the actual production is compared between mechanised methods and hand moulding, the numbers of boxes in relation to moulds or castings produced is very much less with the mechanised methods. It is, therefore, somewhat surprising to find foundries to-day which are quite willing to lay out a large sum of money on a mechanised plant, but when they are asked to erect a good solid foundation by having pattern plates re-made with correct gates and runners, and, moreover, perhaps to scrap their existing boxes, they immediately consider the trouble and expense too great to be undertaken. It is no exaggeration to say, however, that it is not possible to get the best results from a mechanised plant unless these essential factors receive every possible attention initially. Cast-iron boxes which have been broken and repaired are known to have been brought into use once again on an expensive mechanised plant. This is definitely wrong, because, however well a cast-iron box has been repaired, there must be a spring on such a box, with disastrous results to the castings, once they have been repaired; especially is this so when they are subjected to high pressure from the moulding machine, or hard ramming with flat rammers, or the tops of the mould, as is the case when the jolt machines are employed. There is a difficulty in some cases in convincing a foundryman of this, as from general appearance the castings sometimes appear to be alike whether they have been made in a repaired box or not. On the other hand, if a record was taken with regard to the variation in weight of the castings, it is certain that the foundrymen would be amazed at the large difference, and, of course, this is a much more serious thing when the castings in question form part, say, of a stove or some machine which are sold at a price per finished article and not at a price per cwt. or per lb.

Everyone has seen the bad cross-jointed castings going out of the moulding shops at different times, but what steps are taken to see whether the pattern plates are correct or whether the box pin-centres have worn, or whether the box has expanded during moulding operations? These are some of the reasons why, generally speaking, the high-tensile steel moulding boxes are to be preferred to cast-iron, aluminium or mild steel boxes. All boxes should be fitted with hardened steel bushes ground to very close clearances; all box pins should also be made from hardened steel, and to sum up, every possible precaution should be taken to see that there is no movement in the box during moulding, closing or clamping. With regard to clamping the loose hook which is fitted over two steel spigots is to be preferred, and care should be taken to see that these spigots are correctly located in the moulding box sides and that the loose hooks fit these spigots accurately. Such importance is attached to this question of boxes that the author draws particular attention to Fig. 10, which illustrates a recent design.

Ancillary Questions

There are many other questions such as pouring of moulds, which, of course, have to be arranged to suit each individual case, the transfer of castings from the knock-out to the fettling shop, which again will vary according to the class of work to be undertaken, and in recent times, in some foundries, special arrangements have been made for the disposal of gates and runners, knocked off the castings. These subjects are naturally of great interest, but space does not allow them detailed discussion in this Paper.

All that has been attempted is to try to convince founders that mechanisation is a term that can be applied to a large number of various operations in the foundry, and once more it is reiterated in reply to the query put forward by Mr. Tibbenham, at Loughborough, that mechanisation in the foundry is not only worth while but is essential to every foundry in some way or other. It is also emphasised that this statement not only applies to the iron foundry, but also to the steel and non-ferrous shops. Obviously in steel, brass and aluminium foundries, or in jobbing iron foundries, the advantages of complete mechanisation cannot be so fully realised as in a repetition iron foundry, but much can be done in all foundries to improve the castings and to ease the lot of the man in the shop by wise application of mechanisation in some form or other.

Figs. 10 and 11 show a simple sand reconditioning plant installed in a steel foundry in the North of England. This has resulted not only in the production of better castings, but also has saved considerable amounts in labour and in cost of the reconditioning of the facing sand.

Finally, the author showed two films, the first one illustrating a mechanised plant which was put into operation by the Sinclair Iron Company, Limited, Ketley, near Wellington, Shropshire, three years ago, and the second, a plant which was started up at a foundry in the Midlands this year.

The author would like to thank the following gentlemen for their assistance in providing photographs, sanctioning the filming of their plant and finally according permission to use their name in conjunction with this Paper:—Mr. W. A. Stanier, chief mechanical engineer, L.M. & S. Railway, Euston Station, London; Mr. P. Flavel, Sidney Flavel & Company, Limited, Leamington Spa, and Mr. Watkins, the Sinclair Iron Company, Limited, Ketley, near Wellington, Salop.

DISCUSSION

Mr. Erskine (Branch-President), having addressed three queries in writing, Mr. Beech dealt with these before the meeting was thrown open for general discussion.

The Lecturer said the chairman had asked for the estimated or actual saving to be expected on the introduction of a continuous casting system, with moulding machines and a completely mechanised plant, as against ordinary hand floor moulding for the production of (*a*) rain-water connections, and (*b*) stove-plate work. This, he said, was a difficult question to answer, especially in respect to the rain-water connections, because generally this was cored work, and the core-making station had to keep pace with the moulding department and obviously also the core-setting and closing sections. For comparative data, however, one could consider the production of the moulds only, and assume that core-making and core-setting were timed to coincide with the moulding. It was difficult even then to make a comparison, because in hand moulding the men handled the sand, made the mould, cast and knocked-out. Assuming that their moulding operation lasted 7 hrs., and in that time one man and a youth produced twenty complete moulds, on this basis he could state that one pair of machines, operating on a complete, up-to-date continuous-casting plant, should give an average output of 280 moulds in 7 hrs. The plant would not, of course, stop production at the end of 7 hrs., but would certainly go on for 8 hrs., and thus one would expect to obtain 320 complete moulds at the end of 8 hrs.

Obviously it was difficult for many reasons to get at any definite value because he was unaware of the production by hand moulding, and he did not know how much the hand moulders were paid in the Falkirk district. Neither did he know whether the moulders actually prepared sand, cast, and knocked-out. All these operations on a mechanised plant would be done either by separate operators or by mechanical means.

Stove-Plate Work

In the consideration of stove-plate work, the author said that although he did not know exactly the habits or prices paid for this work in the Falkirk district, he had had much experience with this class of work in England. On a straightforward job, on a continuous casting plant with boxes about 30 in. by 16 in. the actual monetary saving would be about 20 to 25 per cent. This was not the only saving, however, and he thought the following figures would be interesting. He estimated, on an average—and the lecturer emphasised that it was impossible for obvious reasons to give definite figures—that one pair of moulding machines, working with boxes about 30 in. by 16 in. on a straightforward job, with a continuous casting plant, would produce more in an 8-hr. day than seven men hand-moulding with seven pattern-plates, in seven rows. He had based this figure on twenty moulds per day per man on the floor, or 140 moulds per day. He also estimated from one pair of machines the foundry would obtain 210 moulds per day minimum with the same size of box, so this would give a basis on which to work.

It was obvious from the above remarks that he had put the maximum amount of moulds against the hand moulders, and not a very extraordinary output from the machines, so that he could not be accused of favouring the machine. Again, the hand moulder would need 140 pairs of boxes to obtain his output, whereas the continuous casting plant would obtain the same production from about 30 to 35 pairs of boxes. When drawing up a balance sheet from the above figures, it would be remembered that the floor space occupied by the hand moulders, to obtain their production of 140 moulds, was far in excess of that needed by the mechanised plant. For instance, a firm having a continuous casting plant recently stated that if they had not installed this plant, it would have been necessary to have made an extension to their foundries of approximately 350 ft. by 150 ft. to obtain the same output. The saving thus shown did not figure in the balance sheet, but was really quite important.

Type of Sand to Use

Replying to Mr. Erskine's question as to the best type of sand to use, presumably for the production of rain-water connections and stove-plate work, Mr. Beech said that in Scotland a great deal of Erith loam was used together with a strongly bonded rock sand to increase the cohesion. This was the sand in use in the South of England on three continuous casting plants for the production of flat, or stove-plate work, and, generally speaking, these sands could be utilised advantageously for both types of castings mentioned.

In stove-plate work it was obvious that considerable care must be taken with the facing sand, especially when a vitreous enamelling process had to be applied, as this was the main cause of scrap. The facing sand must be perfect and must be sieved on to the patterns for this class of work. Two foundries in the Midlands were employing a local Stourbridge or Stourport sand with excellent results.

Mr. Erskine had asked for details of the minimum essential sand treatment when using a continuous casting plant, and how to keep the sand temperature reasonably low. In reply, Mr. Beech said he would have preferred that Mr. Erskine had emphasised the maximum treatment of sand and not the minimum. From what had been said, it was obvious that considerable trouble was taken to recondition the sand. In fact, it was essential to deliver the sand to the machines in perfect condition and to reduce it to shop temperature. The main units in the plant which served to recondition the sand were:—(1) The new sand and coal-dust feed (with automatically-controlled feed); (2) the rotary hexagonal screen; (3) the sand mill, and (4) the disintegrator. Moreover, in several

plants where it was necessary to produce the finest sand, two large storage bunkers were installed, one before the mill and one after the mill, for the reasons that this arrangement gave a larger margin of safety in case of breakdown in part of the plant, and ensured that the same sand should not be used too frequently during the day. The items (1), (2), (3) and (4) were essential to correct sand reconditioning, and care should be taken to see that their design and operating capacity were efficient.

Cooling the Sand

The cooling of sand was a most important point. The sand was always in a steamy condition when it passed through the knock-out, and this was why an apparatus was placed in the knock-out pit to remove the steam, as far as possible, from the pit and pass it through the roof into the atmosphere. Such apparatus served the dual purpose of keeping the pit free from dust and steam, preventing steam and dust from injuring belts and bearings, and starting the process of cooling the sand. The problem was to get the steam out of the sand; if this was accomplished, every time the sand was turned over a decrease in temperature resulted. For instance, there was usually a belt running beneath the knock-out grid which conveyed the sand into the boot of the first elevator, and during its travel it was often joined by a stream of new sand, which was, of course, cold. At the boot of the first elevator, the sand was turned over, and if the elevator was constructed properly, this again helped to cool the sand. There was, obviously, a right and a wrong way of constructing the elevator; when correctly constructed, it acted as a cooling medium, but if it was constructed badly, it had a contrary effect.

It would thus be assumed that every time the sand was turned over, a cooling effect resulted; hence, travel from one belt to another, or into any of the machines, such as the screen, all assisted in this work. However, the greatest agents for cooling were the rotary screen, sand mill and disintegrator, if these machines were correctly designed. In the type of screen, mill and disintegrator dealt with in the Paper, in conjunction with the proper plant design, it had been shown that the sand was definitely at shop temperature when it arrived over the top of the moulding machines. Storage bunkers, of any capacity, did not, contrary to the belief of some people, help to decrease temperatures; in fact, they helped to retain the heat in the sand. The sand mill described would lower the temperature of sand, when working at full capacity, by approximately 26 per cent; the rotary sand riddle, by about 24 per cent; the disintegrator by about 37 per cent.; and the balance to bring the sand to shop temperature was accounted for by the turn-overs and the elevators providing the plant was correctly designed.

MR. R. L. HUNTER said Falkirk foundrymen had not now the monopoly of the light castings trade that they used to have. There was a tendency for trade to move south, and they were faced with the cost of carriage on castings, which was an unavoidable drawback. To offset this, the Falkirk foundries must at least be in the forefront as regards mechanical equipment, and take advantage of every aid to improve quality and reduce costs. Mr. Beech had mentioned the question of synthetic sand as against natural sand. The reason why foundrymen considered the adoption of synthetic sand was that it afforded a quicker method of discovering what type of sand one wanted and of getting it. Grain size, permeability, bond and other properties could be varied easily and quickly, and synthetic sand was certainly being used very successfully in bath works in England. It seemed to offer an easier way of obtaining the properties required than experimenting with the natural sands available, and he would like Mr. Beech's opinion about that.

MR. BEECH agreed that one was probably more able to obtain more positive analysis of the sand for, say, permeability and cohesion by using synthetic sand. On the other sand, he thought the co-ordination of the silica and the bonding material in sand was one of the things which nature had done a great deal better than human beings. He said that he had seen both synthetic and ordinary natural sand go through continuous casting plants, and there was no doubt that, when one poured hot metal into the synthetic sand, it seemed not exactly to disintegrate, but "disco-ordinate" the silica grains from the clay which was added to it to obtain the bond. The buckets of the elevator came up to the top and threw a dust or fine dried clay substance out of the sand, and consequently cohesion and permeability varied very rapidly. The dust or fine clay soon got into the bearings, and one could not prevent it. The mechanised plant could deal with synthetic sand, provided the silt was controlled. The bonded clay was not exactly burnt away, but the co-ordination between the two was spoiled by the effect of the hot metal coming against it. With ordinary plant for hand moulding, and if sand elevators were not in use, the effect was not so deleterious. He did not infer that the sand lost all its clay content, but it certainly lost a considerable amount when elevators, conveyors, etc., were used.

The CHAIRMAN asked if Mr. Beech relied entirely on the high tensile steel boxes and the accuracy of the bushes and the mountings to ensure constant closing accuracy as on thin-walled castings this was important.

MR. BEECH said that he did, and pointed out that in addition hardened steel pins were used. Loose pins were generally adopted, and these had to be machined very carefully so that they made for complete accuracy throughout the whole operation. Supposing one had a pad of sand under the edge of the mild steel box, the box would definitely bend under the pressure and so deflect the face of the mould. If the runner was too near the edge of the box there was also a tendency to distort the box. After several weeks or months in use in the foundry, a mild steel box could be put on the surface table and it would rock, and though it might be only a very small fraction, thereby a variation of weight definitely occurred in the castings. The hardened steel box which was advocated definitely had no disadvantages, and, furthermore, did not rust easily. A box could be left in the rain, and after several weeks they would find very little rust either on the box or on the bushes. It was a more expensive box than mild steel, but in the mechanical plant one did not need the same number of boxes, and the first cost was not of such great importance.

MR. DUNCAN WALKER asked for Mr. Beech's views with regard to the use of compressed air as compared with hydraulic power for the operation of moulding machines.

The LECTURER said that if a moulding machine was to be installed in a foundry where there was no power existing he would undoubtedly recommend the hydraulic type, because the hydraulic machine gave a very much sweeter action than the compressed air one, and the power used with a comparatively small ram was very much higher. Generally, a hydraulic machine was worked at 750 lbs. per sq. in. as against 100 lbs. per sq. in. maximum of compressed air. The cost of running a hydraulic moulding machine was practically negligible; twenty moulding machines would take approximately 5 h.p. to drive the battery. Twenty moulding machines of exactly the same size worked by compressed air would require at least 75 to 80 h.p. A leakage in the hydraulic machine became obvious, but with compressed air a leakage was often neglected. A quarter-inch hole in a compressed-air pipe line with a pressure running at 80 lbs. per sq. in. would take 25 h.p. to cope with the escape from that hole. That would give them some idea of the cost of compressed air compared with hydraulic. While compressed air had many uses in the foundry, he preferred hydraulic power, but machines were being designed now which did not demand so much compressed air as they did previously. So long as the under-sand frame principle of ramming was used almost the same effect was obtained as with a jolting machine with fewer inconveniences. He thought the jolting machine was a very badly thought-out machine, because, from its very nature, it knocked itself to pieces, and upkeep was very high. He preferred the hydraulic machine to the compressed-air machine, especially where the under-sand frame method could possibly be applied.

MR. HUGH LOWE asked how much new sand should be added to renovate the used sand, and had any consideration been given to the specification of sand for the different classes of work?

MR. BEECH pointed out that with a continuously operating sand mill the only term of capacity which could be used was the maximum, say, 30, 15 or 7½ tons per hr. If a stronger sand was needed for that mill either the passage of sand through the mill had to be slower in order to induce more working on the sand, which was quite possible, or, alternatively, a higher proportion of new sand had to be added. A continuously operating mill must not be confused with an intermittent mill or a batch mixer. With a batch mixer the sand was in it for, say, approximately 5 min., but it would not be in a continuous mill for 5 min. even at the slowest speeds. An enormous mill would have to be employed to give a batch mixing effect on a continuous moulding plant. The degree of cohesion or permeability desired was known, and the conditions had to be controlled. The specification of sand was a matter of which the foundry manager himself had control. The designer of the plant had very little to do with it; his job was to design the plant, erect and start it, and once that was done the control of the sand content rested in the hands of the appropriate executive.

The CHAIRMAN heartily thanked Mr. Beech for his interesting Paper. MR. BEECH briefly replied.

Hydrogen in Steel

P. BARDENHEUER and E. H. KELLER, in Report No. 312 of the Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung zu Düsseldorf, describe experimental work on the influence of the hydrogen absorbed during the melting of steel. It was found that when hydrogen is passed into molten steel, the carbon, sulphur and phosphorus contents are not affected, although a reaction with the oxygen takes place. The results obtained indicate that in principle deoxidation of molten steel can be affected by hydrogen. If a carbon steel containing hydrogen is hot-rolled or pressed, hot or red shortness occurs with steels containing less than 0.6 per cent. C. By heat-treatment this condition can be eliminated. On forging nickel-chrome steels with 1 per cent. Cr and 3 per cent. Ni do not exhibit hot-shortness, although some tendency to red shortness. Also, after passing hydrogen into these steels, an oblique fracture is obtained. These deficiencies cannot be removed by heating to 1,000 deg. The hydrogen absorbed by molten steel is reliberated only slowly. During solidification, and just after, the ingots give off a greater proportion of their hydrogen content. The hydrogen liberated during cooling is able to react with the elements associated with Fe, such as S, C and O, by the formation of gaseous compounds. The notched-bar values of plain carbon steels are reduced by hydrogen. On the other hand, the same steels, after hydrogen treatment, exhibit a reduced sensitivity to ageing. By reheating the diminution in notched-bar values due to hydrogen absorption can be eliminated.

Heat-Treatment of Steel Castings

By ROBERT HUNTER, B.Sc., Ph.D.

(*Continued from page* 216.)

Heat-Treatment of Low Alloy Steel Castings

In addition to the refinement of the grain by annealing or normalising, the mechanical properties of steel castings can in many cases be enhanced by further heat-treatment. Mild steel castings, owing to their relatively low carbon content, do not readily respond, and are, consequently, seldom delivered in the hardened and tempered condition. In the annealed or normalised state also they generally possess sufficient ductility and toughness for most purposes.

On the other hand, when a higher tensile strength than is obtainable from this class of casting is desired, a sacrifice in ductility and toughness is inevitable if a plain carbon steel is still employed. For many applications this may not matter, as, for example, where resistance to wear is the primary function. However, in many instances, both high tensile and resistance to shock are required, and this can only be obtained by further heat-treatment of the castings.

One of the most outstanding developments in recent times has been the advancement made in the production of alloy steel castings. To obtain the maximum benefit from the alloying elements, it is generally necessary to subject the castings to a full heat-treatment, and it is the purpose of this section to indicate how this may be carried out.

The advantages accruing to the use of such alloy steels are principally, firstly, that, compared with carbon steels heat-treated to the same tensile strength, the ductility and toughness values are greatly increased, and, secondly, that the composition can be so adjusted that heavy sections can be made to respond uniformly throughout the thickness to the heat-treatment operation.

The heat-treatment of bars and forgings has been common practice for many years, and now presents few difficulties. On the other hand, the heat-treatment of steel castings still presents many problems, particularly when the castings are intricate. This is not a difficulty which is likely to be entirely overcome in time, because, as foundry technique is improved, the founder is called upon to produce even more intricate types of castings. There is no reason, however, to suppose that the technique concerning heat-treatment will not also advance or that compositions requiring simpler heat-treatment processes will not be developed.

As in foundry practice generally, heat-treatment is facilitated by symmetrically shaped castings possessing as uniform a metal thickness as possible. By this means the quenching operation is of equal intensity throughout the casting, and consequently the distortion is reduced to a minimum.

It is proposed to consider first the principles underlying the heat-treatment of steel, and then apply these findings to typical alloy steel castings. For this purpose, one has again to refer to the corner of the iron-carbon equilibrium diagram in Fig. 4. To obtain a homogeneous austenite solution, the temperature of the steel must be raised above line GSE. An allowance in temperature must again be made for the sluggishness of the steel, but, generally speaking, this need not be as great as that desirable for the grain-refinement operation described in the previous section. To ensure the uniform distribution of the carbide, the steel is then cooled quickly by quenching in oil or water, although with some compositions cooling in air may be sufficiently rapid.

In the quenched condition the steel is generally too hard and brittle for most purposes, and has, consequently, to be tempered or drawn to requirements. This is accomplished by re-heating the casting to a temperature below line PSK. Sufficient time must, of course, be allowed at each heat-treatment temperature to ensure the requisite soaking of heavy sections. It is difficult to enunciate definite rules regarding this, but, generally speaking, one hour per inch of thickness should be sufficient. For heavy sections this would have to be increased to two or more hours per inch.

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Owing to their shape and varying thickness of sections, many castings tend to retain very high residual stresses on quenching. It is, consequently, advisable to transfer such castings, while still warm, from the quenching medium to the tempering furnace. Cooling in oil is in most cases preferred to quenching in water, but, if the composition be such that the latter method is essential, the severity of the quench can be greatly reduced by having the water at as high a temperature as is compatible with the degree of quenching desired. On the other hand, the nature of the casting may preclude even quenching in oil, and in such a case the composition must be adjusted to give satisfactory hardening by cooling in still air or by an air blast.

It will be realised from the foregoing that the heat-treatment of castings is not a straightforward process in which a single composition and a standard heat-treatment would be suitable for all castings requiring the same physical properties.

The composition selected depends largely on the size, shape and physical tests desired from the casting. The size influences the composition, because large castings will normally have a slower rate of cooling than small ones, and consequently require a higher percentage of alloying elements. On the other hand, the shape influences the choice of quenching medium. Water, as a rule, cannot be used except for the simplest forms, and, therefore, more expensive compositions suitable for oil quenching or air cooling may be required. The physical properties desired have naturally a large influence on the choice of steel, and, broadly speaking, the higher the tensile strength and the greater the toughness desired, the more expensive the steel will be because of the increased proportions of alloying elements which are then necessary.

It is not possible in this Paper to consider all the various compositions of alloy steel castings and their respective heat-treatments. Consequently, no attempt is made to catalogue such information, but particulars are given of representative compositions which have gained a certain degree of popularity.

In the foregoing, the author has considered for convenience the heat-treatment of steel castings on the assumption of Fig. 4 holding true. The various alloying elements influence to some extent the relative positions of the various lines on the diagram, but it is quite outside the scope of this Paper to discuss the effect of the different elements, either singly or in combination, on this aspect. Suffice it to say, therefore, that the temperatures given hereafter are in conformity with the principles enunciated, and have been found in practice to give satisfactory results.

NICKEL STEELS

Low Carbon 2 per cent. Nickel Cast Steel

Low carbon 2 per cent. nickel is a very popular composition for cast steel in America. It is recommended for locomotive frames, castings for mining, excavating and steel mill machinery and other parts subject to shock and fatigue stresses. The retention of impact resistance and ductility at sub-zero temperatures makes this composition particularly suitable for machinery operating in cold climates.

Analysis.—C, 0.20 per cent. max.; Si, 0.15 per cent. max.; Mn, 0.60 to 0.90 per cent.; S, 0.05 per cent. max.; P, 0.05 per cent. max., and Ni, 2.0 per cent. min.

Recommended Heat-treatment.—940 deg. C., 2 hrs. per in. thickness, air cool; 815 to 845 deg. C., 1½ hrs. per in. thickness, air cool; 595 to 680 deg. C., temper, cool in air or furnace.

Table I[5] shows typical test results obtained in the ordinary course of production with this composition.

Table I.—*Typical Test Results on Low Carbon 2 per cent. Nickel Cast Steel.*

Composition. Per cent.						Y.P. Tons per sq. in.	M.S. Tons per sq. in.	E. on 2 in. Per cent.	R. of A. Per cent.
C	Si	Mn	S	P	Ni				
0.20	0.33	0.81	0.024	0.011	2.11	21.7	36.4	32.0	60.7
0.18	0.37	0.76	0.023	0.015	2.16	21.5	33.8	29.5	61.8
0.20	0.30	0.67	0.023	0.011	2.04	23.4	36.4	32.5	59.9
0.19	0.30	0.89	0.024	0.012	2.07	24.5	36.4	27.5	52.2
0.17	0.30	0.84	0.022	0.012	2.09	22.7	35.4	32.6	62.3
0.19	0.30	0.91	0.023	0.012	2.14	22.9	38.0	29.0	52.0

Medium Carbon 2 per cent. Nickel Cast Steel

A medium carbon 2 per cent. nickel cast steel is used for castings demanding higher strength and elastic properties than those given by the low carbon 2 per cent. nickel steel described above.

Analysis.—C, 0.20 to 0.30 per cent.; Si, 0.25 to 0.40 per cent.; Mn, 0.70 to 0.90 per cent.; S, 0.05 per cent. max.; P, 0.05 per cent. max., and Ni, 2.0 per cent. min.

Recommended Heat-treatment.—900 deg C., cool in air; 650 deg. C., temper. Typical test results obtained from this composition are given in Table II.[6]

Table II.—*Typical Test Results on Medium Carbon 2 per cent. Nickel Cast Steel.*

Composition. Per cent.					Y.P. Tons per sq. in.	M.S. Tons per sq. in.	E. on 2 in. Per cent.	R. of A. Per cent.
C	Mn	S	P	Ni				
0.28	0.97	0.040	0.034	1.99	27.8	42.2	26.5	48.4
0.28	1.00	0.045	0.035	2.16	27.1	43.4	26.5	53.6
0.27	0.91	0.047	0.033	1.98	25.5	42.2	25.5	47.5
0.30	1.05	0.071	0.030	1.95	28.3	46.5	25.0	54.8

CHROMIUM STEEL CASTINGS

In chromium steel only those castings of a low alloy content generally containing 1.0 to 1.5

per cent. chromium will be considered for the moment. These castings may be heat-treated by quenching in water, oil or air, depending on the intricacy, carbon content and the duties required of the material. A composition found suitable as an inexpensive medium tensile steel is as follows:—C, 0.30 to 0.40 per cent.; Si, 0.50 per cent. max.; Mn, 1.0 per cent.; S, 0.04 per cent. max.; P, 0.04 per cent. max.; Cr, 1.0 to 1.5 per cent. This quality is found to be in furnace; 830 deg. C., quench in oil; 620 deg. C., cool in oil. A typical test from a batch of castings given the above heat-treatment gave the following results:—Yield point, 36.0 tons per sq. in.; maximum stress, 46.8; elongation, 20.0 per cent.; reduction of area, 35 per cent.; Brinell hardness, 197; Izod impact, 34, 32, and 36 ft.-lb.

The above are examples of steel castings of comparatively low alloy content which have been selected as representative types. Various other compositions are frequently used, such as nickel-chrome-molybdenum, nickel-vanadium, nickel-molybdenum, nickel-manganese, chrome-molybdenum, manganese, nickel-manganese, etc. These by no means complete the list of compositions which have been found to yield satisfactory castings.

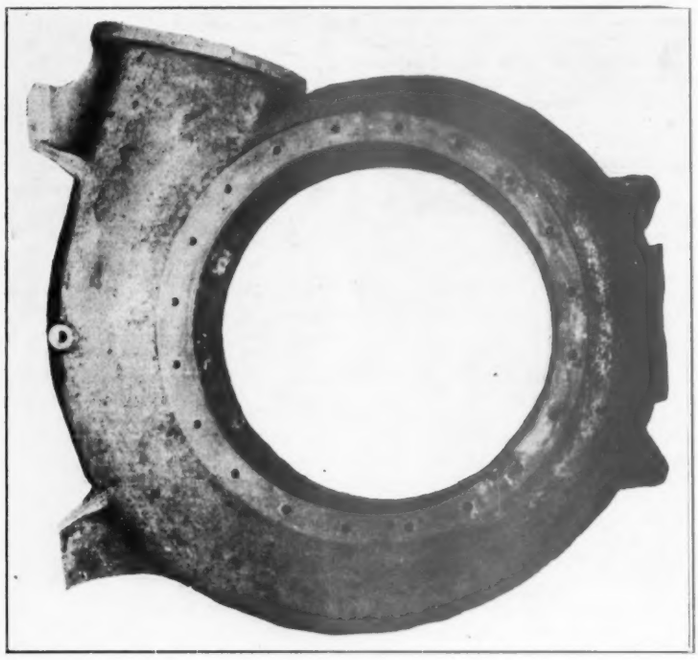

Fig. 9.—A Volute of a 10-ft. dia. Sand Pump in High-Carbon Chromium Steel.

quite suitable for small and medium size castings and is generally given the following heat-treatment:—900 to 950 deg. C., cool in furnace; 860 deg. C., cool in air, oil or water; 660 deg. C., temper. After the above heat-treatment the following mechanical values are obtainable:—Maximum stress, 40 to 50 tons per sq. in., associated with 20 to 25 per cent. elongation.

Of the high carbon varieties a good hard wearing composition is one containing 0.80 to 1.0 per cent. carbon. This quality, of course, is not particularly tough, and consequently should not be used for parts subjected to shock. Fig. 9 shows a volute of a large sand pump about 10 ft. in dia. made of this type of steel. The heat-treatment given to this casting after refinement of the grain as above, consisted of cooling in air from 860 deg. C. An air blast was also directed on the inside of the casing as this area was wanted as hard as possible in order to resist abrasion. The Brinell hardness of the casting after this heat-treatment was 280 to 300 and a test-bar heat-treated along with the casting gave the following results:—Maximum stress, 62 tons per sq. in.; elongation, 11.0 per cent.

NICKEL-CHROME CASTINGS

A wide range of compositions of nickel-chrome castings is available. The chromium may vary from small amounts up to 2 per cent. and the nickel up to 5 per cent. Likewise the carbon content may be up to 0.60 per cent., although the range 0.20 to 0.40 per cent. covers most requirements. A typical example at the low end of the range is as follows:—C, 0.30 to 0.40 per cent.; Si, 0.50 per cent. max.; Mn, 1.0 per cent. max.; S, 0.04 per cent. max.; P, 0.04 per cent. max.; Ni, 1.5 to 2.0 per cent., and Cr, 0.5 to 1.5 per cent.

A suitable heat-treatment given to this composition is as follows:—900 to 950 deg. C., cool

Certain compositions have to be cooled rapidly from the tempering temperature, otherwise, although the tensile figure may be satisfactory, the casting may be brittle. This phenomenon is called temper brittleness, and applies principally to nickel-chromium, manganese, and manganese-nickel compositions. It is clearly revealed by the Izod impact test, and, as this is not regularly taken on castings, it is consequently a point which should not be overlooked by the steel founder.

Heat-Treatment of Stainless Steels

There have been so many developments in the heat-treatment of stainless steels within recent years that it is only possible to mention a few representative types. For use in conjunction with super-heated steam, and for conditions of relatively mild corrosion, there is still a considerable tonnage of castings produced of the original plain chromium type.

The limits of analysis may be arbitrarily set as follow:—C, 0.20 to 0.35 per cent.; Si, 0.50 per cent. max.; Mn, 1.0 per cent. max.; S, 0.03 per cent. max.; P, 0.03 per cent. max.; Ni, 1.0 per cent. max.; and Cr, 12 to 14 per cent. As a rule, it is not necessary with this composition to subject the castings to a preliminary grain-refinement treatment. The heat-treatment generally given to them, therefore, is:—950 deg. C., cool in air or oil; 750 deg. C., temper, cool in air.

In most cases, cooling in air is sufficient. As a rule, it is not advisable for the chromium to exceed 14 per cent., otherwise difficulty may be experienced in obtaining satisfactory grain refinement by heat-treatment. It will also be observed that the quenching and tempering temperatures, compared with those previously mentioned, are considerably higher. This is due to the effect of chromium in raising the critical range of the steel. The minimum resistance to corrosion with this quality is found after tempering at 550 to 600 deg. C.,[7] but as the mechanical tests obtained after this heat-treatment are not of any special significance, this range is in any case seldom used.

After the above heat-treatment the following mechanical test specification is readily complied with:—Maximum stress, 45 to 55 tons per sq. in.; elongation, 20 to 25 per cent.; bend, 180 deg. not fractured.

Lower carbon alloys can also be readily cast and are given a similar heat-treatment to the above. Excellent mechanical tests are again obtained. The tensile range is generally about 10 tons per sq. in. lower and the elongation about 5 per cent. higher.

(*Concluded on page* 240.)

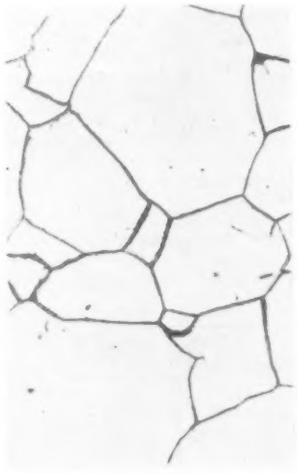

Fig. 10.—Disintegrated Austenitic Stainless Steel with Broadened Grain Boundaries. × 100.

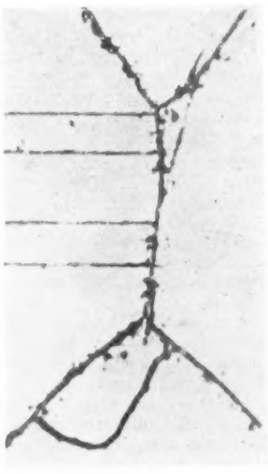

Fig. 11. — Precipitated Chromium Carbide Particles in Grain Boundaries of Austenitic Stainless Steel. × 3,000.

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A composition possessing greater resistance to corrosion and particularly suitable for use in contact with brasses and bronzes is the 18:2 composition.

The analysis of this type is:—C, 0.10 to 0.25 per cent.; Si, 0.50 per cent. max.; Mn, 1.0 per cent. max.; S, 0.05 per cent. max.; P, 0.05 per cent. max.; Ni, 1.5 to 3.0 per cent., and Cr, 16 to 20 per cent. Excellent castings can be made from this alloy, but are not quite as ductile as the previous composition described.

The heat-treatment given to the castings of this composition is as follows:—950 deg. C., cool in air; 650 deg. C., temper, cool in air.

After this heat-treatment the following tests may be expected:—Maximum stress, 50 to 60 tons per sq. in.; elongation, 15 per cent. min.

Probably, however, the greatest quantity of stainless steel castings produced are of the austenitic variety, *i.e.*, sufficient nickel and chromium are added to depress the critical range so that on quenching the austenitic condition, stable at elevated temperatures, is retained.

A typical composition is as follows:—C, 0.10 to 0.25 per cent.; Si, 0.50 per cent. max.; Mn, 1.0 per cent. max.; S, 0.03 per cent. max.; P, 0.03 per cent. max.; Ni, 14.0 per cent., and Cr, 18.0 per cent. To render this quality completely austenitic, it is necessary to quench the castings in oil or water from about 1,050 deg. C.

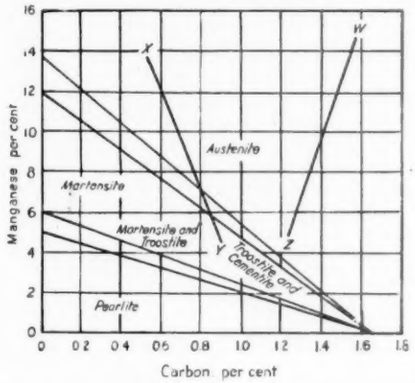

FIG. 12.—CARBON-MANGANESE CONSTITUTIONAL DIAGRAM.

After this heat-treatment the following range of mechanical test values are obtained:—Maximum stress, 30 to 40 tons per sq. in.; elongation, 40 to 60 per cent. This quality, even in the "as cast" condition, exhibits excellent ductility, and the heat-treatment, therefore, is principally carried out in order to render the steel in the best possible condition to withstand corrosion. Normally, if this type of steel is slowly cooled through the range of temperatures of 900 to 500 deg. C., the chromium carbides are precipitated at the grain boundaries. Under corrosive conditions rapid attack takes place at this point, and the casting consequently quickly becomes disintegrated. Fig. 10 shows the micro-structure of disintegrated metal in which the broadened grain boundaries will be observed. Fig. 11 shows the grain boundaries at exceedingly high magnification of 3,000 diameters in which the precipitated carbide particles will be observed.

It should be mentioned, however, that suitable compositions have now been developed which do not exhibit the undesirable feature of intergranular corrosion even after being subjected to the above temperature range. Other alloys to those mentioned above are also sometimes added to make the alloy particularly suitable for withstanding special corrosive conditions, but the heat-treatment of such castings follows the principles outlined above.

Heat-Treatment of Manganese Steel Castings

No review on the subject of heat-treating steel castings would be complete without reference to the reasons underlying the heat-treatment of high manganese steel castings for whose development industry is indebted to Sir Robert Hadfield, Bt. By suitable adjustment of the carbon and manganese contents it is possible by quenching from the correct temperature to retain the high temperature austenitic phase. Under the influence of cold work on the surface, this phase changes to extremely hard wearing martensite, and so the combination of the wear resisting surface and the toughness characteristic of austenite is obtained.

Fig. 12 shows the approximate relationship between the carbon and manganese content and the constituents present. This constitutional diagram is based on the work of Guillet, but lines XY and WZ have been added as the result of more recent investigations. Between these lines pure austenite may be obtained by quenching in water from about 1,060 deg. C. To the left of line XY is the zone of martensitic steels, and to the right of WZ steels are found after quenching to contain free cementite.

The composition which is generally adhered to lies within the following limits:—C, 1.0 to 1.4 per cent.; Si, 0.30 to 1.0 per cent.; Mn, 10 to 14 per cent.; S, 0.04 per cent. max.; and P, 0.10 per cent. max.

In the cast condition manganese castings are relatively brittle, partly due to the presence of free cementite and partly because, on slow cooling from the casting temperature, some of the austenite transforms to troostite or martensite. To obtain complete solution of the cementite and to obtain the steel in the austenitic condition, the castings are quenched in water from 950 to 1,050 deg. C.

Owing to the difficulty of preparing, mechanical tests are not regularly taken from manganese castings. The Brinell hardness can, however, sometimes be conveniently determined. In the quenched condition the Brinell hardness is generally 180 to 200.

A recent development[a] of this quality has been the addition of 3 to 5 per cent. nickel to it, whereby a simple normalising treatment is quite effective in producing the austenitic structure. It also retains its strength and toughness better at elevated temperatures.

Conclusions

In the foregoing an attempt has been made to give examples of the heat-treatment of steel castings of qualities which are most frequently manufactured for general engineering purposes. This Paper is not intended to summarise all the various compositions and their respective heat-treatments, but is intended to explain in as non-technical language as possible the principles underlying the various heat-treatment operations. Once these are grasped, it should not be difficult for the founder to select the most suitable heat-treatment temperatures for his purpose.

While, in the case of carbon steels, it is customary to give the castings a preliminary grain-refinement treatment before hardening and tempering, this is not always done with alloy steels. To obtain the best mechanical tests, the preliminary treatment is recommended, particularly with low alloy steels, but sometimes it is not considered that the enhancement of properties so obtained is justified on economic grounds.

The author wishes to express his thanks to the directors of the Clyde Alloy Steel Company, Limited, for permission to publish this Paper, and to the various members of the staff of the same company who have assisted in its compilation.

Institute of Metals

At the annual dinner of the Institute of Metals, held in London last week, the President (Mr. W. R. Barclay) announced that the International Nickel Company of Canada had offered to award a platinum medal to the author of the best Paper each year irrespective of age, nationality, etc.

Metal Spraying

At the Annual Meeting of the Institute of Metals, held in London last week, MR. E. C. ROLLASON presented a Paper on "Metal Spraying: Processes and Some Characteristics of the Deposits," in the course of which he pointed out that zinc coatings afforded excellent protection for iron and steel without danger of distortion, and were particularly useful for steel windows, light-gauge sheet metal, springs, and non-metallic articles. Zinc coatings afforded an excellent base for paint. Aluminium coatings were resistant to sulphurous atmospheres, and the very pure metal was gaining favour as a coating for the steel parts of aircraft. Aluminising was, of course, used to prevent scaling in furnace equipment operating at high temperatures (up to 950 deg. C.) and to protect exhaust manifolds on aircraft. Tin was used principally for coating food vessels.

Lead, nickel, copper, steel and stainless-steel coatings all had their uses, the harder metals particularly for building-up worn machine parts and for filling blow-holes and cracks in castings where only compressive strength was required. Among the more novel applications might be mentioned the treatment of insulators, radio apparatus, diathermic bandages, and wallpaper, due to the conductive and electrical shielding properties of the coatings.

The author concluded that each of the three types of metal-spray equipment had characteristic advantages which would allow all of them to survive competition and become useful tools in the engineers' hands. Owing to its low costs, the powder process would undoubtedly prove successful in spraying large surfaces with zinc, especially when the coat was subsequently painted. This powder-spraying pistol also offered possibilities of spraying brittle metals and alloys of high melting point which could not be drawn into wire, although deposits of the higher melting point metals which had been examined were not wholly satisfactory as yet.

The molten-metal instrument could produce thick coatings of the low-melting-point metals at a reasonable price, and should prove useful to the galvaniser doing contract work, especially as the metal in ingot form was used and neither acetylene nor oxygen was required. The wire pistol, on the other hand, would without doubt hold the field in building up thick deposits on worn articles, and also for producing heat-resisting surfaces. Even in the production of zinc coating, where the cost was higher than in the case of the other processes, the wire pistol offered advantages in the spraying of internal work.

Iron and Steel Production

The British Iron and Steel Federation reports that there were 115 furnaces in blast in the United Kingdom at the end of February, one more than at the end of January. The production of pig-iron in February amounted to 603,700 tons, compared with 650,700 tons in January, and 584,700 tons in February, 1936; the month's production included 125,200 tons of hematite, 340,200 tons of basic, 110,000 tons of foundry, and 17,700 tons of forge pig-iron.

The production of steel ingots and castings in February amounted to 995,900 tons, compared with 998,900 tons in January, and 938,500 tons in February, 1936.

A PETITION to the High Court for the sanctioning of the scheme of arrangement between the Tinsley Rolling Mills Company, Limited, and its members, and the confirmation of the reduction of the company's capital from £150,000 to £100,000, was sanctioned by Mr. Justice Simonds last Monday.

CLEAN IRON
SAVES COKE IN THE CUPOLA

The cleaner iron given by Workington Machine Cast Pig (free from sand fused to the surface) saves fuel in the cupola. A foundry which used Machine Cast Pig reports the following results:

- Coke consumption decreased by 20%
- Slag from the cupola reduced by 45%
- Limestone charged reduced by 50%
- Quantity of iron melted increased by 24%
- Hanging eliminated completely.
- Castings cleaner.
- Metal composition more regular.
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BRANCH OF THE UNITED STEEL COMPANIES LIMITED

W.33

The Week's News in Brief

Trade Talk

THE SHOTTS IRON COMPANY, LIMITED, have decided to erect a brickworks at Roslin.

SIR JAMES LAING & SONS, LIMITED, Sunderland, have secured an order for an oil tanker from Norwegian owners.

THE STAFF OF Jones & Campbell, Limited, held a social in the Plough Hotel, Larbert, recently. Mr. P. F. Jones presided.

THE BROWN-FIRTH RESEARCH LABORATORIES is to be visited this summer by a delegation of prominent American industrialists and bankers.

THE COMBUSTION APPLIANCE MAKERS' ASSOCIATION (SOLID FUEL) have changed their address to 54, Victoria Street, London, S.W.1.

THE INSTITUTE OF WELDING has changed its address to 104, Victoria Street, London, S.W.1. The new telephone number is Victoria 1768-9.

THE L.M. & S. RAILWAY COMPANY, LIMITED, have ordered a bucket hopper dredger to be used in Ayr Harbour from W. Simons & Company, Limited, Renfrew.

NEGOTIATIONS ARE NEARLY COMPLETE for the sale of Armstrong Whitworth & Company, Limited's locomotive building works, at Scotswood-on-Tyne, to the Locomotive Manufacturers' Association.

THE ENGINES for three vessels to be built by the Blyth Dry Docks & Shipbuilding Company, Limited, Blyth, for the Admiralty will be supplied by the North-Eastern Marine Engineering Company, Limited, Sunderland.

GEORGE COHEN, SONS & COMPANY, LIMITED, of London and elsewhere, have bought for demolition the plant and machinery of the Rose Works at Swansea, and the Phœnix and the Crown Works at Port Talbot of British Briquettes, Limited.

MR. W. TAIT, of 6, Harriet Walk, London, S.W.1, has acquired the sole representation in the United Kingdom for the sale of Ullrich sand-preparing plants. An installation made in a Midlands foundry will shortly be available for demonstration.

AN ORDER for a 2,500-ton coasting steamer has been received by S. P. Austin & Son, Sunderland, from France, Fenwick & Company, of Newcastle-upon-Tyne. The engines will be built by the North-Eastern Marine Engineering Company, Limited, Sunderland.

THE DIRECTORS OF Vickers, Limited, recommend for approval in general meeting, a dividend for the year 1936 at the rate of 10 per cent., less income tax, on the ordinary stock of the company. This dividend, if approved, will be paid on Saturday, April 3, 1937.

HENRY LEES & COMPANY, LIMITED, 81, Mitchell Street, Glasgow, have received a contract for a mechanical coaling plant of 250 tons capacity, to be installed at Darnall in connection with the L.N.E. Railway Company's £2,500,000 electrification scheme in the Midlands.

THREE HUNDRED BATH MOULDERS employed at the works of Shanks & Company, Limited, Barrhead, who went out on strike on March 10 on account of grievances concerning working conditions and wages, resumed work the following day on the undertaking that the firm would remedy the grievances.

IN THE ANNUAL REPORT of the Ironfounding Workers' Association, Mr. Hugh Murdoch, general secretary, states that there has been some difficulty in finding a sufficient number of men to meet the labour requirements of the light castings industry. Only 1.96 per cent. of the members are unemployed, which is the lowest number ever recorded.

AN AMALGAMATION between James Allan Senior & Son, Limited; Craig & Donald, Limited; James Bennie & Sons, Limited; G. & A. Harvey, Limited; and Loudon Bros., Limited, has resulted in the formation of a new company under the style of Scottish Machine Tool Corporation, Limited. The authorised capital is £400,000 in 2,000,000 ordinary shares of 4s. each.

THOS. W. WARD, LIMITED, Sheffield, have acquired the works of the Langloan Iron & Chemical Company, Limited. There are five blast furnaces with stove and auxiliary plant, which have a capacity of 65,000 to 100,000 tons per year. It is possible that an attempt will be made to put the furnaces into blast again before dealing with the property in any other way.

TWO HUNDRED MOULDERS in the employ of the Falkirk Iron Company, Limited, struck work on March 10. The stoppage is the outcome of a dispute relating to working conditions in the foundry. The men are all piece-rate workers, and they claim to be paid full rates for moulds completed, but which are not cast the same day, due to a shortage of metal. The men have now returned to work.

THE STANTON IRONWORKS COMPANY, LIMITED, near Nottingham, have completed a plant of eight machines, which has been confined to the production of centrifugal pipes of 3 in. dia. and 2½ in. dia. This plant has now been in operation for the past six months. The company are now proceeding to put down a further plant, consisting of ten machines, to be confined to the production of 4 in. dia. pipes. It is hoped to get these new works into production during the present year.

UPNOR FOUNDRY SAND, after a lapse of some years, has again become available by the formation last November of a new company, the Medway Brickworks & Quarries, Limited, of Lower Upnor, near Rochester, Kent. This century-old quarry is situated on the Medway, just opposite to Chatham Dockyard, where 100-ton barges can be berthed. It is also quite near to the London main road. It is claimed that it was the existence of Thanet sand which determined the choice of the site of Woolwich Arsenal.

Contracts Open

Andover, March 22.—Cast-iron pipes, for the Town Council. The Borough Surveyor, Municipal Offices.

Frome, April 3.—Eight miles of spun-iron water mains, varying from 5 in. to 2 in. in dia., for the Rural District Council. Parker Pearson & Ross Hooper, Dallas Chambers, Chippenham, Wilts. (Fee £1, returnable.)

Montevideo, April 15.—1,500 m. of cast-iron piping (internal dia.—125 mm.), 15 cast-iron bends, 12 tees and 4 sluice gates, for the National Cold Store. The Department of Overseas Trade. (Reference T.Y. 31,214.)

Retford, March 23.—29,924 yds. of 3-in., 4-in. and 6-in. spun-iron pipe, for the East Retford Rural District Council. Mr. J. Turrill, surveyor, 2, Market Square, Retford, Notts. (Fee £3 3s., returnable.)

Warwick, March 23.—510 yds. of 6 in. dia., 4,630 yds. of 4 in dia., and 3,500 yds. of 3 in. dia. spun-iron pipes, for the Rural District Council. Mr. S. Douglas, engineer, 50, Priory Road, Kenilworth. (Fee £3 3s., returnable.)

Company Reports

Broom & Wade, Limited.—Interim dividend of 7½ per cent.

Vickers, Limited.—Dividend for the year 1936 of 10 per cent. on the ordinary stock.

Platt Bros. & Company (Holdings), Limited.—Dividend on the 4½ per cent. preference shares for the half-year ended March 31.

Ketton Portland Cement Company, Limited.—Interim dividend at the rate of 10 per cent. per annum on the ordinary shares on account of the year to June 30, 1937.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Ferith Fireclay Company, Limited, Storrs Bridge Works, Loxley, Sheffield.—Nominal capital, £5,000. Permanent directors: A. Marshall, T. Marshall, and A. Marshall, Junr.

G. & W. Walmsley, Limited.—Capital, £4,000. Ironfounders, etc. Directors: G. Walmsley, 46, Peabody Street, Darwen; W. Walmsley, O. T. McKernan, and A. E. Cowell.

MR. A. J. GRANT, managing director of Thos. Firth & John Brown, Limited, and chairman of Firth-Vickers Stainless Steels, Limited, is to be the next President of Sheffield Chamber of Commerce.

Personal

MR. WILLIAM PAGE has been appointed representative at the Forfar depôt of Barclay, Ross & Hutchison, Limited.

MR. A. DUNBAR AND MR. A. B. WINDER, directors of the English Steel Corporation, Limited, have been appointed directors of Vickers Armstrong, Limited.

MR. J. ROBERTS, B.Met., has been appointed metallurgist at the Darlington Forge, Limited. For a number of years he was with the English Steel Corporation in the metallurgical research department.

MR. WILLIAM W. WILSON, consulting engineer, of Newcastle-upon-Tyne, has had bestowed upon him by the King of Sweden the decoration of Chevalier, First Class, of the Order of Vasa, in appreciation of services to that country.

MR. W. R. ABBOTT, London manager of the engineering firm of Alldays & Onions, Limited, Birmingham, was entertained to dinner at the Midland Hotel, Birmingham, on March 13, the occasion being the completion of fifty years' service with the company.

DR. H. E. MERRITT, chief engineer to David Brown & Sons (Hudd.), Limited, is to take up a Government appointment. In addition to being a leading authority on gear design, he has been closely associated with the design and production of the wide range of products associated with the name of David Brown & Sons, including transmissions for road and rail vehicles, machine tools and measuring equipment, pumps and hydraulic systems, industrial power transmission equipment in general, and the "Radicon" reducer in particular.

THE COUNCIL OF THE IRON AND STEEL INSTITUTE announces that Bessemer Gold Medals for 1937 have been awarded to Col. N. T. Belaiew, C.B., and to M. Aloyse Meyer. Col. Belaiew, of Paris, has, during the last 25 years, published a number of Papers dealing mainly with the crystallisation of metals, and in particular steel. M. Aloyse Meyer, of Luxemburg, is an honorary Vice-President of the Iron and Steel Institute, and is well known as the head of the Société Anonyme Arbed, the Luxemburg combine, and the second largest iron and steel company in Europe. Since 1928 he has been President of the Entente Internationale de l'Acier.

Obituary

MR. WILLIAM MOSCRIP, director and secretary of the National Steel Foundry (1914), Limited, Kirkland, Leven, died on March 10, aged 55. He has been a director of the firm since 1915 and was a member of the Scottish Branch of the Institute of British Foundrymen.

WE REGRET to announce the death of Mr. Fred. B. Erb, President and general manager of Eaton-Erb Foundry Company, Detroit. He was a Past-President of the American Foundrymen's Association and in 1929 participated in the London International Foundrymen's Convention, presided over by Mr. Wesley Lambert, C.B.E. Mr. Erb was born in 1886 and was at one time foundry manager of the Packard Motor Company. He started in business on his own account in 1925 and in 1932 he, with Mr. Eaton, purchased the Halley Permanent Mould Machine, Inc. A strong supporter of international foundry co-operation, his loss will be deeply felt all over the world.

Forthcoming Events

Institute of British Foundrymen

MARCH 20.

East Midlands Branch:—Annual General Meeting; Members' Problems; at Loughborough College, Loughborough, at 6 p.m.

Lincolnshire Section:—Students' Papers, at the Technical College, Monks Road, Lincoln, at 7 p.m.

Wales and Monmouth Branch:—Annual General Meeting, at University College, Newport Road, Cardiff, at 6.30 p.m.

MARCH 27.

Newcastle-upon-Tyne Branch:—Annual General Meeting; Report on the work of the Technical Committee by E. B. Ellis and G. Elston at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

The Institute of Vitreous Enamellers

MARCH 25.

Scottish Section:—"Some Defects in Cast-Iron Enamels," Paper by J. G. Roberts, at the Royal Technical College, Glasgow, at 7.30 p.m.

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Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

- ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

- **Typical Cylinder Pig Iron Specification**

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

- **Typical Malleable Pig Iron Specification**

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

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Raw Material Markets

All available supplies of home-produced iron and steel are required for the fulfilment of contract commitments, and makers are hard pressed to keep deliveries up to schedule. In many cases this has not been possible, although, as a whole, consumers have received excellent service under existing conditions. Indian exporters have intimated their willingness to send additional supplies of iron to this country, while extra tonnages are also expected from Germany. Every ton will be needed, however, and new business on home and export account is hard to place. Efforts are being made to secure an equitable share of the semi-finished material available for the independent re-rollers of this country, and provision is being made for fixing the tonnage of semi-finished material to be supplied to a given works, by reference to its normal output of finished products, plus a percentage allowance for waste, croppings, etc. There is still a scarcity of information regarding the arrangements to control supplies and prices of scrap.

Pig-Iron

MIDDLESBROUGH.—Current activity only involves the despatch of deliveries under contract, and new business is confined to remote dates for delivery at prices which may be in operation at the time. Consumers are having to take supplies of Midland grades of foundry iron instead of Cleveland material in many cases. There is little hope of relief by means of the abolition of the import duty on pig-iron, for it is fully realised that much higher quotations are obtainable on the Continent. An embargo on the export of pig-iron is favoured in many quarters. No. 3 Cleveland G.M.B. foundry iron is quoted at 81s. per ton in the Middlesbrough area, 83s. on the North-East Coast, 84s. in Falkirk, and 87s. in Glasgow. Producers of hematite are firm in their stipulation that unexpired contracts will be subject to the revised prices which are to come into force as from June 1. Meanwhile, users are obtaining as heavy deliveries as are possible. East Coast mixed numbers are quoted at 97s. 6d. per ton on the North-East Coast, 103s. in Sheffield, and 108s. 6d. in the Midlands. These figures are subject to a rebate of 5s. per ton.

LANCASHIRE. — Pig-iron consuming works are very active in this area. For delivery to users in the Lancashire price zone, Staffordshire and Derbyshire No. 3 foundry iron is quoted on the basis of 89s. per ton, with Northamptonshire at 87s. 6d., and Derbyshire forge iron at from 84s. to 86s., according to the class of user. It is increasingly difficult to procure adequate tonnages of hematite. Quotations are firm. For delivery equal to Manchester, West Coast grades are quoted at 106s., with East Coast material at 105s. 6d. per ton. Scottish foundry iron is quoted around 105s. per ton, delivered in the Manchester area.

MIDLANDS.—While it is sometimes possible for odd lots of pig-iron to be obtained by users who have run short, new business generally will not be considered. The question of prices is a matter for discussion, and the possibility of an increase before the end of June is not discounted. Meanwhile, for delivery to Birmingham and Black Country stations, Northants No. 3 iron is quoted at 83s. 6d., with Derbyshire, Lincolnshire and North Staffordshire at 86s. per ton. In view of the exceptional activity now prevailing among the industrial concerns in the Midlands, many works are endeavouring to obtain additional supplies—usually without success. West Coast mixed numbers are quoted at £5 9s. 6d., with East Coast No. 3 at £5 8s. 6d. and Welsh mixed numbers at £5 8s. The foregoing figures are inclusive of delivery to Midland stations, and are subject to an extra of 1s. 6d. per ton if delivery into works is required. The prices of low-phosphorus iron are not controlled and vary from £5 to £5 10s., delivered this district. As a result of the shortage of the cheaper grades of hematite, supplies of low-phosphorus iron are in increased demand. Medium-phosphorus iron is quoted at from 90s. to 100s., with refined iron at a minimum of £6 17s. 6d. per ton, delivered the Midlands.

SCOTLAND.—Deliveries against contract have been satisfactory generally, but new business is difficult to place. No. 3 foundry iron is quoted at 88s., with 2s. 6d. per ton extra for No. 1 grade, f.o.t. furnaces. No. 3 Cleveland iron is quoted at 84s. f.o.t. Falkirk, and 87s. f.o.t. Glasgow, but these figures are purely nominal. Active conditions continue to prevail with the light-castings founders, while the steelworks also are well employed. Mixed numbers of hematite are quoted at 98s., less 5s. rebate, and basic, British and Indian, at 82s. 6d., less 5s. rebate, f.o.t. steelworks in this area.

Coke

In connection with the negotiations for the formation of an international coke cartel between Great Britain, Germany, Holland, Belgium and Poland, it is announced that it is proposed to implement an international convention from April 1 next. The regulation and control of the exportation of coke, the regulation of prices, and the promotion of the exportation of coke are the most important objects of the convention. The inland demand for coke is heavy, and many users are willing to purchase supplies for delivery up to the end of the year.

Steel

Trading in the steel market has been restricted by the difficulty of finding suppliers able to accept fresh business, says the official report of the London Iron and Steel Exchange. New business in semi-finished steel has almost ceased, as the works have sold their output for many weeks to come. Only small parcels are being brought into the country against the Continental quota, and the production of the British works is insufficient for the market's requirements. As a result of this position, some of the works have had to curtail the output of finished steel. The works turning out raw material are operating at as near capacity as the situation permits, but are unable to keep pace with the abnormal call for steel. The position is rendered worse by the fact that the arrivals of Continental finished steel against the quota are very much in arrears. Export business is limited to urgent transactions, as the home demand absorbs all the available material.

Scrap

The *communiqué* issued after a meeting of the International Steel Cartel last week, which announced that representatives of the European steel-producing countries principally interested in the purchase of iron and steel scrap had agreed to co-operate in the purchase and distribution of all imported scrap, has been received with considerable interest in this country. Details of the scheme for the centralised purchasing of steel scrap and the fixation of selling prices are still awaited, and business is being restricted by the lack of information. In most districts trade has only involved small tonnages for early delivery. In Scotland, where new prices are already in operation, quite substantial tonnages have changed hands, but the shortage of supplies of many grades of scrap is restricting business.

Metals

Wide price fluctuations have again been seen on the non-ferrous metal markets. The tin quotation has been at the highest level for many years, despite a substantial decline following unexpected quota developments. Industrial activity, both at home and in the United States, is on a heavy scale; the tin-plate mills throughout the world are particularly well engaged. Prices of all metals close lower on the week's trading.

Copper.—According to a New York message, world stocks of refined copper declined during February by 6,024 tons to 330,073 tons. The apparent world consumption was 179,000 tons. World production by mines and smelters totalled 186,000 tons. Prices have been firm during the past week, but no sensational changes have occurred. Supplies for prompt delivery are undoubtedly very short. Buying is on a good scale in the United States, and business has been transacted at up to 17 cents per lb., although 16.25 cents is a more usual figure.

Daily market prices :—

Cash.—Thursday, £78 to £78 5s.; Friday, £76 5s. to £76 15s.; Monday, £77 to £77 5s.; Tuesday, £72 12s. 6d. to £72 15s.; Wednesday, £71 10s. to £71 15s.

Three Months.—Thursday, £74 15s. to £75; Friday, £72 7s. 6d. to £72 10s.; Monday, £74 7s. 6d. to £74 10s.; Tuesday, £71 12s. 6d. to £71 15s.; Wednesday, £70 17s. 6d. to £71 2s. 6d.

Tin.—The question of the quota for the second quarter of 1937 is still a matter for speculation. On March 5 it was announced that the quota would remain at 100 per cent. of standard tonnages, and much surprise was occasioned last Friday when the International Tin Committee issued a *communiqué* stating that the quota had been increased to 110 per cent. On this day a remarkable slump in the price of tin took place. When Mr. Grenfell asked the President of the Board of Trade in the House of Commons on Monday whether his attention had been called to the increase in the price of block tin; and whether, in view of the addition to the cost of manufacturing tinplates consequent upon these soaring prices, he would call for action by the Tin Control Scheme to prevent the infliction of this burden upon this important industry in the special area of South Wales, Captain Euan Wallace, Secretary, Overseas Trade Department, replied in writing to the effect that the Committee were holding a further meeting on March 18. Although nothing official is known at the time of writing, it would seem to imply that the Committee have realised that they have seriously under-estimated the current rate of world consumption, and a further increase in the quota is generally anticipated to result from to-day's (Thursday's) meeting. Rumours are bound to be put into circulation while market conditions are in such an unsettled state, and it has been suggested that the control of output is to be temporarily abandoned. Unfulfilled orders for tinplates from all over the world in the Welsh tinplate market now exceed 7,000,000 boxes. Six additional mills were started at Briton Ferry on Tuesday. Prices have risen and the outlook promises excellent activity over a long period.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £301 to £302; Friday, £290 to £291; Monday, £311 to £311 10s.; Tuesday, £296 10s. to £297 10s.; Wednesday, £295 15s. to £296.

Three Months.—Thursday, £295 to £295 10s.; Friday, £282 15s. to £283 5s.; Monday, £303 15s. to £304; Tuesday, £289 10s. to £290; Wednesday, £288 15s. to £289 5s.

Spelter.—Consumption of this metal is at a very high rate, and fears are expressed as to a serious shortage of supplies. High-grade metal is particularly difficult to obtain. Large tonnages are being taken up in the United States with the price at 7.50 cents per lb., East St. Louis. It is reported from the United States that the price of zinc ore has been raised $3.50 to $49.50 per ton. This is the highest price for ten years. All available supplies are taken up.

Official quotations were as follow :—

Ordinary.—Thursday, £37; Friday, £34 11s. 3d.; Monday, £35 10s.; Tuesday, £33 15s.; Wednesday, £33 8s. 9d.

Lead.—Business has again been on a heavy scale in this market, and prices are firm. Substantial tonnages are changing hands in the United States, and it is reported that the price of lead ore has been advanced by $10 to $95.51 per ton, which is the highest level for ten years.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £36 7s. 6d.; Friday, £36; Monday, £34 12s. 6d.; Tuesday, £33 16s. 3d.; Wednesday, £32 18s. 9d.

WHEN THINKING OF
SANDBLAST
THINK OF
RICHARDSON'S
Established 1887.
We Supply Re-Conditioned & New
SAND BLAST PLANTS
AND
AIR COMPRESSORS.
Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.
Phone: MIDLAND 2281.
Grams: "SANDBLAST, B'HAM."
R. J. RICHARDSON & SONS, Ltd.,
Commercial Street, Birmingham.

For **"easy stripping"** use

YORKSHIRE SAND

Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

It is because of the refractoriness of the sand and of the toughness of the mould surface that castings made with Yorkshire Sand are distinguishable by their excellent finish.

Please address all enquiries to the nearest Sales Office :

GENERAL REFRACTORIES LTD.,

Genefax House, Sheffield

Telephone : Sheffield 31113 (6 lines). *Telegrams : "Genefax, Sheffield."*

LONDON OFFICE: Russell House, Adelphi, W.C.2.
Telephone: Temple Bar 7361. Telegrams: "Genefax, Rand-London." Mr. A. C. Turner.

SCOTTISH OFFICE: 48, West Regent Street, Glasgow. Telephone: 3009. Telegrams: "Genefax, Glasgow." Mr. C. A. G. Thomson.

MANCHESTER OFFICE: 9, Albert Square, Manchester, 2. Telephone: Blackfriars 6130. Telegrams: "Genefax, Manchester." Mr. S. G. Throssell.

SOUTH WALES OFFICE: Metropole Chambers, Wind Street, Swansea. Telephone: 3680 Telegrams: "Genefax, Swansea." Mr. D. Hood-Williams.

CARDIFF OFFICE: 17, Windsor Place, Cardiff. Telegrams: "Genefax, Cardiff." Mr. F. E. Rutter.

MIDDLESBROUGH OFFICE: Halifax Buildings, Exchange Place.
Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." Mr. C. Souness.

★

Read what an IMPORTANT STEELFOUNDER says :—

"During the 40 years I have been connected with Steel Foundry work, considerable changes have taken place. Away back, we had Steel Moulders' Composition, Old Crucible Pots, etc., and each works claimed to have its own 'secret' moulding composition. High Silica Sand has eliminated practically all these from many foundries and to-day we have your 'Yorkshire Sand' which acts almost like a chill, and leaves the skin of the casting blue-black and as clean as cast iron.

The hot steel lies quietly against the wall of sand, and often when the casting has been lifted out of the mould, the latter looks as if it could be used over again, just like a permanent mould."

RAW MATERIALS—PRICE LIST

(Wednesday, March 17, 1937)

COPPER

	£	s.	d.
Standard cash	71	10	0
Three months	70	17	6
Electrolytic	76	0	0
Tough	76	2	6
Best selected	76	12	6
Sheets	107	17	6
India	87	12	6
Wire bars	77	17	6
Ingot bars	77	17	6
H.C. wire rods	81	7	6
Off. av. cash, Feb.	59	5	6
Do., 3 mths., Feb.	59	6	9
Do., Sttlmnt., Feb.	59	5	3
Do., Electro, Feb.	64	11	10½
Do., B.S., Feb.	64	13	9
Do., wire bars, Feb.	65	3	6
Solid drawn tubes			15½d.
Brazed tubes			15½d.
Wire			11½d.

BRASS

Solid drawn tubes	14d.
Brazed tubes	16d.
Rods, drawn	12½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g.	11½d.
Wire	11½d.
Rolled metal	11½d.
Yellow metal rods	8½d.

TIN

	£	s.	d.
Standard cash	295	15	0
Three months	288	15	0
English	298	0	0
Bars	298	5	0
Straits	298	0	0
Australian			—
Eastern	284	15	0
Banca	298	0	0
Off. av. cash, Feb.	233	19	7½
Do., 3 mths., Feb.	234	16	8½
Do., Sttlmt., Feb.	233	19	6

SPELTER

	£	s.	d.
Ordinary	33	8	9
Remelted	32	12	6
Hard	29	15	0
Electro 99.9	35	18	9
English	34	12	6
India	29	10	0
Zinc dust	31	10	0
Zinc ashes	11	5	0
Off. aver., Feb.	25	4	5½
Aver. spot, Feb.	25	2	5½

LEAD

	£	s.	d.
Soft foreign ppt.	32	18	9
Empire (nom.)	34	11	3
English	35	15	0
Off. aver., Feb.	28	6	2½
Aver. spot, Feb.	28	6	4½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	50	5	0	to 50	15	0
Do., V.M. ex-whse.	50	5	0	to 50	15	0
Rods				52	0	0

ANTIMONY

English	88	0	0	to 89	0	0
Chinese, ex-whse.				75	0	0
Crude, c.i.f. (nom.)				41	0	0

QUICKSILVER

Quicksilver	14	7	3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—						
25%				9	5	0
45/50%	10	15	0	to 12	0	0
75%	15	15	0	to 17	0	0
Ferro-vanadium—						
35/50%				12/8 lb. Va		
Ferro-molybdenum—						
70/75% carbon-free				4/6 lb. Mo.		
Ferro-titanium—						
20/25% carbon-free				9d. lb.		
Ferro-phosphorus, 20/25%				£21 to £22		
Ferro-tungsten—						
80/85%				4/- lb.		
Tungsten metal powder—						
98/99%				4/1½ lb.		
Ferro-chrome—						
2/4% car.				31	17	6
4/6% car.				21	10	0
6/8% car.				21	0	0
8/10% car.				21	0	0
Ferro-chrome—						
Max. 2% car.				32	10	0
Max. 1% car.				35	15	0
Max. 0.5% car.				36	10	0
70% carbon-free				9½d. lb.		
Nickel—99.5/100%				£180 to £185		
"F" nickel shot				£165	0	0
Ferro-cobalt, 98/99%				7/3 lb.		
Metallic chromium—						
96/98%				2/5 lb.		
Ferro-manganese—						
76/80% loose	£13	15	0	to 14	5	0
76/80% packed	£14	15	0	to 15	5	0
76/80% export				£13	0	0
Metallic manganese—						
94/96% carbon-free				1/3 lb.		

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{7}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ⅛ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	3	8	0	to 3	10	0
Mixed iron and steel	3	5	0	to 3	7	6
Heavy cast iron	3	8	0	to 3	10	0
Good machinery	4	2	6	to 4	5	0
Cleveland—						
Heavy steel	3	2	0	to 3	9	0
Steel turnings						—
Heavy cast iron	3	17	6	to 4	2	6
Heavy machinery	4	0	0	to 4	5	0
Midlands—						
Short heavy steel	3	12	6	to 3	15	0
Light cast-iron scrap	2	17	6	to 3	2	6
Heavy wrought iron				3	17	6
Steel turnings				2	5	0
Scotland—						
Heavy steel	3	4	6	to 3	7	0
Ordinary cast iron	3	17	6	to 4	0	0
Cast-iron borings	2	0	0	to 2	2	6
Wrot-iron piling				4	0	0
Heavy machinery	4	5	0	to 4	6	3

London—Merchants' buying prices, delivered yard.

Copper (clean)	60	0	0
Brass	36	0	0
Lead (less usual draft)	28	10	0
Tea lead	24	0	0
Zinc	23	0	0
New aluminium cuttings	74	0	0
Braziery copper	54	0	0
Gunmetal	56	0	0
Hollow pewter	200	0	0
Shaped black pewter	150	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	83/6
,, No. 3	81/-
,, No. 4	80/-
Forge No. 4	80/-
Hematite No. 1	98/-*
Hematite M/Nos.	97/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	98/-*
,, d/d Birm.	109/6*
Malleable iron d/d Birm.	135/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	83/-
,, No. 3 fdry.	86/-
Northants forge	80/6
,, fdry. No. 3	83/6
,, fdry. No. 1	86/6
Derbyshire forge	83/-
,, fdry. No. 3	86/-
,, fdry. No. 1	89/-
Scotland—	
Foundry, No. 1, f.o.t.	90/6
,, No. 3, f.o.t.	88/-
Cleveland No. 3, Glasgow	87/-
,, ,, Falkirk	84/-
Scottish hem. M/Nos. d/d	98/-*
Sheffield (d/d district)—	
Derby forge	80/6
,, fdry. No. 3	83/6
Lincs forge	80/6
,, fdry. No. 3	83/6
W.C. hematite	103/6*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	89/-
Staffs fdry. No. 3	89/-
Northants fdry. No. 3	87/6
Cleveland fdry. No. 3	89/-
Glengarnock, No. 3	105/-
Clyde, No. 3	105/-
Monkland, No. 3	105/-
Summerlee, No. 3	105/-
Eglinton, No. 3	105/-
Gartsherrie, No. 3	105/-
Shotts, No. 3	105/-

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)				11	17	6
Nut and bolt iron	10	5	0	to 10	15	0
Hoops				12	15	0
Marked bars (Staffs) f.o.t.				14	7	6
Gas strip				12	15	0
Bolts and nuts, ¾ in. × 4 in.				17	10	0 and up.
Steel—						
Plates, ship, etc.	9	10	6	to 9	13	0
Boiler plts	10	0	6	to 10	3	0
Chequer plts.				11	3	0
Angles				9	3	0
Tees				10	3	0
Joists				9	3	0
Rounds and squares, 3 in. to 5½ in.				10	3	0
Rounds under 3 in. to ¼ in. (Untested)				9	10	0
Flats—8 in. wide and over				9	8	0
,, under 8 in. and over 5 in.				9	13	0
Rails, heavy	8	5	0	to 8	10	0
Fishplates				12	10	0
Hoops (Staffs)				10	5	0
Black sheets, 24g. (4-t. lots)				12	0	0
Galv. cor. shts. (,,)				14	0	0
Galv. flat shts. (,,)				14	10	0
Galv. fencing wire, 8g. plain				16	0	0
Billets, soft				6	5	0
Sheet bars	6	2	6	to 6	10	0
Tin bars	6	2	6	to 6	10	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	15d.
Sheet to 10 w.g.	16d.
Wire	16½d.
Rods	17d.
Tubes	21½d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
to 10g.	1/7½ to 2/2½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/6½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	23.76
No. 2 foundry, Valley	22.00
No. 2 foundry, Birm.	18.38
Basic, Valley	21.50
Malleable, Valley	22.00
Grey forge, Valley	20.50
Ferro-mang. 80%, seaboard	80.00
O.-h. rails, h'y, at mill	39.00
Billets	34.00
Sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Chicago	2.15
Steel bars	2.20
Tank plates	2.05
Beams, etc.	1.90
Skelp, grooved steel	1.80
Steel hoops	1.95
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.40
Wire nails	2.50
Plain wire	2.60
Barbed wire, galv.	3.05
Tinplates, 100-lb box	$4.85

COKE (at ovens)

Welsh foundry	32/6 to 33/-
,, furnace	27/- to 28/-
Durham foundry	28/-
,, furnace	26/- to 27/-
Scotland foundry	28/-
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		21/6 to 23/6
,,	28×20	,,	43/- to 47/-
,,	20×10	,,	30/- to 31/-
,,	18¾×14	,,	22/- to 23/-
C.W.	20×14	,,	17/6 to 18/9
,,	28×20	,,	35/6 to 36/9
,,	20×10	,,	25/3 to 25/9
,,	18¾×14	,,	18/3 to 19/3

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£10	10	0	to £11	10	0
Bars-hammered, basis	£18	10	0	to £20	0	0
Bars and nail-rods, rolled, basis	£17	10	0	to £18	10	0
Blooms	£14	0	0	to £14	10	0
Keg steel	£26	0	0	to £29	0	0
Faggot steel	£18	0	0	to £23	0	0
Bars and rods dead soft, st'l	£14	0	0	to £15	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 9.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.		
Mar.	11	..	78	0	0	inc.	17/6
,,	12	..	76	5	0	dec.	35/-
,,	15	..	77	0	0	inc.	15/-
,,	16	..	72	12	6	dec.	87/6
,,	17	..	71	10	0	,,	22/6

Electrolytic Copper

			£	s.	d.		
Mar.	11	..	80	0	0	inc.	20/-
,,	12	..	77	10	0	dec.	50/-
,,	15	..	79	0	0	inc.	30/-
,,	16	..	77	0	0	dec.	40/-
,,	17	..	76	0	0	,,	20/-

Standard Tin (cash)

			£	s.	d.		
Mar.	11	..	301	0	0	No	change
,,	12	..	290	0	0	dec.	220/-
,,	15	..	311	0	0	inc.	420/-
,,	16	..	296	10	0	dec.	290/-
,,	17	..	295	15	0	,,	15/-

Tin (English ingots)

			£	s.	d.		
Mar.	11	..	301	0	0	dec.	10/-
,,	12	..	290	0	0	,,	220/-
,,	15	..	311	0	0	inc.	420/-
,,	16	..	297	0	0	dec.	280/-
,,	17	..	298	0	0	,,	20/-

Spelter (ordinary)

			£	s.	d.		
Mar.	11	..	37	0	0	inc.	15/-
,,	12	..	34	11	3	dec.	48/9
,,	15	..	35	10	0	inc.	18/9
,,	16	..	33	15	0	dec.	35/-
,,	17	..	33	8	9	,,	6/3

Spelter (Electro, 99.9 per cent.)

			£	s.	d.		
Mar.	11	..	39	12	6	inc.	16/3
,,	12	..	37	5	0	dec.	47/6
,,	15	..	38	1	3	inc.	16/3
,,	16	..	36	5	0	dec.	36/3
,,	17	..	35	18	9	,,	6/3

Lead (soft foreign, prompt)

			£	s.	d.		
Mar.	11	..	36	7	6	inc.	7/6
,,	12	..	36	0	0	dec.	7/6
,,	15	..	34	12	6	,,	27/6
,,	16	..	33	16	3	,,	16/3
,,	17	..	32	18	9	,,	17/6

Lead (English)

			£	s.	d.		
Mar.	11	..	38	5	0	inc.	5/-
,,	12	..	38	0	0	dec.	5/-
,,	15	..	36	10	0	,,	30/-
,,	16	..	35	15	0	,,	15/-
,,	17	..	35	15	0	No	change

Imports and Exports of Pig-iron, Castings, etc., in February and the Two Months 1937, compared with February and the Two Months 1936.

	February.		Two months.		February.		Two months.	
	1937.	1936.	1937.	1936.	1937.	1936.	1937.	1936.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	7,444	13,967	11,707	25,552	22,969	46,257	35,931	84,242
,, ,, Other British Countries	—	5,070	—	5,070	—	21,167	—	21,167
,, ,, Foreign Countries	2,198	1,846	4,611	4,806	12,907	11,339	25,075	29,739
Total	9,642	20,883	16,318	35,428	35,876	78,763	61,006	135,148
Castings and forgings	711	140	1,284	613	21,602	4,827	41,099	16,124
Cast pipes and fittings	140	124	233	287	4,409	2,617	6,599	5,912
Stoves, grates, etc.	51	48	101	136	8,001	7,380	13,216	12,237
Baths	826	589	1,499	1,245	20,916	13,763	37,248	29,353
Hollow-ware, all kinds	297	280	600	561	16,423	16,473	32,350	33,283
Exports.								
Pig-iron, forge and foundry	4,357	6,214	8,485	14,287	15,918	30,724	31,818	65,521
,, acid	2,328	6,223	4,912	11,192	7,621	29,380	16,350	50,958
,, basic	—	281	28	281	—	1,485	112	1,485
Total	6,685	12,718	13,425	25,760	23,539	61,589	48,280	117,964
Castings and forgings	324	304	684	677	13,296	10,786	25,919	24,251
Cast pipes and fittings, up to 6 in. diameter	3,950	4,208	8,322	8,001	47,614	45,087	96,034	88,439
,, ,, over 6 in.	3,423	2,774	7,931	5,268	24,410	23,057	66,964	42,977
Stoves, grates, etc.	1,035	960	1,922	1,870	47,358	52,880	92,242	100,089
Sanitary cisterns	263	264	509	558	8,289	8,255	16,078	17,552
Bedsteads, including tubes therefor	450	428	852	847	15,935	15,417	31,152	31,259
Cast hollow-ware	444	509	852	883	14,878	16,464	29,274	29,744

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG

IRON

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND
FERRO-SILICON—FERRO-CHROME

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED

IRON Moulder desires change. Including apprenticeship, 37 years' experience machine tool work, marine, and brass. Experienced leading Core Maker. Similar position preferred.—Box 298, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN, iron foundry, desires change. Sound knowledge all sections steam, compressor, hydraulic, pneumatic, machine tools, sewage, gas engine and producer castings. Several type moulding machines. Output 40 tons weekly. Particulars upon request.—Box 288, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN or Assistant desires change. Experienced jobbing, repetition, high-duty and ordinary cast irons. Young, keen and energetic. Guaranteed to get results.—Box 296, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager wishes to meet with a real live firm who have an up-to-date plant making quantity iron castings. A directorship would be considered. Salary required £750 to £1,000 per annum.—Box 286, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRYMAN, age 33, practical and technical experience all branches; 7 years' supervisory experience; loose, plate pattern machine moulding, continuous plant; for engineering, motor and electrical trades; also stove and cooker lines; grey iron, steel and semi; also non-ferrous, cupola practice. Good timekeeper and disciplinarian. Seeks permanent engagement.—ROBINSON, 37A, Kendrick Road, Bilston, Staffs.

STEEL Foundry Manager is open for engagement. First-class metallurgist and steel maker from Siemens, Tropenus, Stock oil Converter, and electric furnaces. Understanding the manufacture of steel castings from A to Z. Either home or abroad.—DAVID DOUGLAS MCGUFFIE, 43, High Fernley Road, Wyke, Bradford.

A VACANCY occurs in the Editorial Staff of an old-established Technical Journal for a man able to write on metallurgical matters, particularly in regard to the fabrication of sheet metal products and workshop practice from practical experience. Apply, giving full details of experience, age, specimens of any technical articles written, also salary asked, to: Box 1874, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

LABORATORY Assistant required for firm of gas appliance manufacturers. A sound scientific knowledge and laboratory experience are essential. State age, experience, and salary required.—Box 292, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—Smart young Salesmen for refractory and insulating bricks. Conversant with modern furnace construction.—Box 290, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED for India, Steel Melter (single) with at least five years' experience in charge of Electric Steel Melting Furnaces of Stobie or Heroult type, competent to produce steel correct to all British standard specifications for Carbon Steels, also Manganese Nickel and Nickel-Chrome Steels. Salary £45 per month plus bonus on output. Three years' agreement, passage paid. Four months' leave on half-pay after three years' satisfactory service. Apply with full particulars of experience and copy of testimonials to: 4253, COURIER, Dundee.

SITUATIONS VACANT AND WANTED.—*Contd*

FIRST-CLASS Brass Moulders, Croydon District. Full details, age, experience.—Box 300, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN for jobbing foundry in Cornwall. General iron castings and some non-ferrous work. Twenty moulders employed. Reply for interview in London, stating wages required, age, experience, etc.—Box 278, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY

LARGE Iron-Ore Mine, near Banbury, with rail sidings. Face of ore 16 ft. deep and 2 ft. below the surface. To be Let on Lease. For further particulars apply: MESSRS. RAWLENCE & SQUAREY, 4, The Sanctuary, Westminster Abbey, London, S.W.1.

TENDER

METROPOLITAN WATER BOARD.

TENDERS FOR THE SUPPLY OF STORES, ETC.

THE Metropolitan Water Board invite Tenders for the supply of the undermentioned stores and services for the period of twelve months commencing June 1, 1937.

Contract No.

1.—Bricks, firebricks, cement, etc.
8.—Iron and steel.
9.—Bolts and nuts, screws, files, shovels, steam tubes, etc.
12.—Fuel oil, oil (lubricating), kerosene, motor spirit, greases, etc.
19.—Iron, brass, gunmetal and other castings.
20.—G.M. stopcocks and ferrules, outlets and caps for fire hydrants.
22.—Timber (hard woods).
23.—Maintenance of weighing machines.

Tenders must be submitted on the official forms, which may be obtained on and after Wednesday, March 17, 1937, from the Chief Engineer, by personal application at the offices of the Board (Room 171), or upon forwarding a stamped addressed envelope (large).

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board, and endorsed in the manner indicated in the Form of Tender, must be delivered at the offices of the Board (Room 122) not later than 12 o'clock Noon on Monday, April 5, 1937.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery Avenue,
E.C.1
March 10, 1937.

MACHINERY

WANTED.—Rotary Furnace of Brackelsberg type or similar, suitable for melting 1½ tons per hr.: either coal or oil fired.—Box 294, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

'Phone **98** Staines.

AIR Receiver, 18 ft. 6 in. by 4 ft. 6 in. Horizontal Compressor, 200 cub. ft. at 100 lbs.
8-in. Root's Blower (as new), 5 lbs. pressure. Vertical Boiler, 8 ft. 6 in. by 3 ft. 6in., 80 lbs.

HARRY H. GARDAM & CO., LTD., STAINES.

NEW Dwarf Cupola, to melt 10 to 15 cwts per hr. New Worm-geared Ladles, 5 tons. 25 cwts., 15 cwts. and 10 cwts. capacity Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

MACHINERY—*Continued*

FOR SALE.—Pneumatic Jarring Turnover and Pattern Draw Moulding Machines, No. 6 Ajax, No. 9 Ajax take 45 in. by 36 in. by 16 in. boxes. No. 12 Ajax, size of table 76 in. by 60 in., 18 in. pattern draw. Three Hand Moulding Machines by Darling & Sellars. The above machines are for immediate disposal in order to save storage, and are in good condition. May be inspected Yorkshire, West Riding.—Write Box 280, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & CO., LTD., Station Works, Ecclesfield, Sheffield.

ELECTRIC CUPOLA BLOWERS (large stock), including two 50-h.p. 3/50/400 volts, 2,900 r.p.m.; Keith Blackman; 12-in. outlet.
30-h.p. ditto; 12-in. outlet.
5-h.p. ditto; 6-in. outlet.
20-h.p. 460 volts d.c., 2,400/1,900 r.p.m.; 10-in. outlet.
EXHAUST FANS (large stock), electrical and belt driven.
ELECTRIC RUNWAY LIFTING BLOCKS:
One 4½-ton 460 volts d.c., Vaughan.
Two 2-ton ditto, Morris.
One ½-ton 220 volts d.c., Morris (as new).
One ½-ton 3/50/440 volts, Aabacas.
Two Reavell Rotary Compressors, 12 lbs. sq. in. pressure; 750 cub. ft. direct-coupled on bedplate to 60 h.p. S.R., 3/50/400 volts motor.
½-cwt. Pilkington Self-contained Pneumatic Hammer.
Geared Foundry Ladles, 9, 4, 3½, 2½ and 1 ton, etc.
AIR COMPRESSORS: 30 in stock in sizes 500 to 20 cub. ft.
ELECTRIC MOTORS: Large stock to suit almost all electric systems.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.

Vert. Cochran BOILER; 11′ 3″ x 5′; 100 lbs. w.p.
Two 16″ "Princeps" LITTLE SCORCHER STEAM DRYERS.
2,000′ 2″ S. & S. PIPING.
Five first-class second-hand Green's FUEL ECONOMISERS, each of 320 pipes, 9′ long; re-insurable at 200 lbs. w.p.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD.

'Phone: 287 SLOUGH

SEVERAL Good Foundry Grinders, Price, £5 to £20.

12′ square Sand Blast Room Plant complete and in good condition. Price, £180.

Four Morgan Oil-fired Tilting Furnaces reconditioned — 450-lbs. capacity. Also 250-lbs. and 600-lbs. capacity in stock. CHEAP.

Large stock of Moulding Machines, Compressors and A.C. Motors.

PLEASE SEND US YOUR ENQUIRIES.

ALEX. HAMMOND, *Foundry Machinery Merchant.*
14, AUSTRALIA ROAD, SLOUGH
BUY FROM ME AND SAVE MONEY!

(Small advertisements continued on opposite page.)